State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES

STATE WATER PROJECT SUPPLEMENTAL WATER PURCHASE PROGRAM

Draft
Program Environmental Impact Report
State Clearinghouse 94082033

ENVIRONMENTAL SERVICES OFFICE **December 1996**

Pete Wilson	Douglas P. Wheeler	David N. Kennedy
Governor	Secretary for Resources	Director
State of California	The Resources Agency	Department of Water Resources

ANNOUNCEMENT REGARDING EXTENSION OF COMMENT PERIOD
STATE WATER PROJECT
SUPPLEMENTAL WATER PURCHASE PROGRAM DRAFT EIR

On February 11, 1997, the California Department of Water Resources (DWR) released a draft environmental impact report (draft EIR) for the State Water Project Supplemental Water Purchase Program. The **deadline for comments (originally April 15, 1997) is extended to May 30, 1997,** to provide an opportunity for more extensive review by interested parties. Please submit any written comments to: Ms. Dale Hoffman-Floerke, Department of Water Resources, Environmental Services Office, P.O. Box 942836, Sacramento, CA 94236-0001. Written comments already submitted will be part of the official record and will be responded to in the final EIR.

The draft EIR is available for review at a number of locations statewide, including the following: Resources Agency Building, 1416 Ninth Street, Room 115, Sacramento; Alameda County Library, 2450 Stevenson, Fremont; Butte County Library, 1820 Mitchell, Oroville; Colusa County Library, 738 Market, Colusa; Contra Costa County Library, 1750 Oak Park, Pleasant Hill; Fresno County Library, 2420 Mariposa, Fresno; Kern County Library, 701 Truxtun, Bakersfield; Los Angeles County Library, 7400 E. Imperial Hwy, Downey; Merced County Library, 2100 O Street, Merced; Yolo County Library, 226 Buckeye, Woodland; Yuba County Library, 303 2nd Street, Yuba City. Additionally, all documents referenced in the draft EIR are available for review at DWR, 3251 S Street, Sacramento, California.

The California Department of Water Resources is proposing the Supplemental Water Purchase Program to increase water supply reliability for State Water Project (SWP) contractors. The draft EIR describes the six-year Program which could transfer as much as 400,000 acre-feet of water annually from willing sellers to participating SWP contractors in amounts that, together with their SWP allocations, would not exceed their annual entitlements. Water for this Program would be acquired from two sources, primarily in the Sacramento and San Joaquin Valleys: from surplus reservoir storage and through substitution of groundwater supplies for water normally provided by surface flows. The Program would use existing water storage and transport facilities, and incorporates features which minimize and mitigate overall environmental impacts, however, there is the potential for unavoidable significant impacts to some reservoir-related recreation. The Program will benefit California by reducing economic losses due to water shortages in regions supplied by the SWP.

In addition to extending the public comment period, DWR will hold one or more public workshop(s) to invite interested parties to learn more about the Program. DWR staff members will be available at the workshop(s) to discuss the Program and respond to questions. A Notice of Public Workshop(s), including the meeting date, time and location, will be mailed later.

To receive a copy of the draft EIR, contact DWR Bulletins and Reports at (916) 653-1097. If you have any questions about the proposed Program, contact Scott Jercich at (916) 653-4547. If you have questions about the draft EIR, contact Dale Hoffman-Floerke at (916) 227-7530.

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C—091692

SUMMARY

The Department of Water Resources is proposing a Supplemental Water Purchase Program, a 6-year, short-term program designed to allow transfers of water from willing sellers to participating SWP Contractors when the Department of Water Resources is unable to meet SWP Contractors' annual entitlement requests for contracted water. The proposed program will provide for water transfers through options or direct purchase agreements. Implementation of the proposed program will depend on a variety of factors, including level of water demand, restrictions to protect endangered species, and hydrologic and reservoir storage conditions. The Department of Water Resources has prepared this Program Environmental Impact Report to address possible impacts on the environment that might occur as a result of implementing the proposed program.

Water acquired by the Supplemental Water Purchase Program would come primarily from two sources: stored surface water and groundwater substitution, whereby a portion of a water district's or farmer's water supply would be acquired and replaced by pumping an equivalent amount of local groundwater. Likely areas from which surface water might come include the Sacramento River tributaries and major tributaries of the San Joaquin River. Groundwater substitution sources would likely be from the Sacramento Valley. It is anticipated that a maximum of 200,000 acre-feet would be available from surface water sources and 200,000 acre-feet from groundwater substitution. This program would primarily use existing water production and transport facilities. No new construction of facilities is contemplated, although some minor construction (such as monitoring wells) is possible.

If a Drought Water Bank is formed and activated during the term of the proposed program, a portion of the Supplemental Water Purchase Program water would be set aside to help meet the needs of smaller entities.

Water transfers to both urban and agricultural areas are expected to reduce environmental and economic losses resulting from water shortages. Many fish species are expected to benefit from greater instream flows in source regions.

State Water Project service areas that could receive water from the proposed program could include Alameda, Solano, Napa, Santa Clara, Santa Barbara, and San Luis Obispo counties. SWP service areas in the San Joaquin Valley and Southern California could also receive water from this program.

The proposed program is designed to avoid significant adverse environmental impacts that would otherwise occur due to surface water purchases, groundwater substitution, and exports through the Delta. Due to the uncertainty in sources and amounts of water transferred, the Department of Water Resources has identified all potentially significant impacts and a menu of programwide mitigation measures that would be implemented to avoid or minimize significant adverse impacts to the environment (Table S-1).

The proposed program will comply with all applicable laws and regulations, including the California Water Code, Fish and Game Code, Federal and State Endangered Species acts, Clean Water Act, State Water Project permits, and agreements entered into by the Department of Water Resources. Exports through the Delta will be in accordance with objectives of the State Water Resources Control Board's 1995 Water Quality Control Plan.

Most water transfers are expected to be exported through the Delta, using SWP facilities. To the degree possible, water purchased from upstream reservoirs would be released at times for maximum benefits and minimum adverse impacts to fish. Exports through the Delta would occur only during July through October to avoid impacts to winter-run chinook salmon and delta smelt. Transfers of water from the proposed program would increase instream flows. In some areas, transfers delayed to late summer and early fall would benefit migrating adult salmon.

The 1995 biological opinions for winter-run chinook salmon and delta smelt contain operational constraints and incidental take restrictions for Delta pumping operations that result in non-jeopardy operation of the State Water Project and Central Valley Project. Any Delta water transfers associated with the Supplemental Water Purchase Program would comply with conditions in these biological opinions. In addition, the CALFED Operations Group would be monitoring operations and fish abundance during the transfers and, should problems arise with the take of listed or sensitive species, would consult informally to develop measures to avoid adverse impacts to fish. For non-listed races of chinook salmon, as well as steelhead and striped bass, the Department of Water Resources would provide mitigation in the form of funds in

accordance with Four Pumps Mitigation Program to offset direct losses.

Water release schedules for water purchased from reservoirs would be developed in consultation with reservoir operators, Department of Fish and Game, and others to avoid or minimize impacts to carryover storage, provide the most beneficial flows for aquatic resources, and minimize impacts to recreation.

Wildlife impacts resulting from purchases of stored surface water in reservoirs and groundwater substitution activities are expected to be minor or nonexistent.

The proposed program would include groundwater substitution in areas where groundwater can be extracted in lieu of taking a surface water supply. Groundwater monitoring would be conducted as part of the program and if impacts are found to be related to the proposed program, changes would be made, such as well spacing, pumping curtailment, and possibly financial compensation, to minimize significant impacts related to groundwater substitution.

Some impacts to reservoir-related recreational opportunities could occur as a result of the proposed project. Lowered water levels during peak recreation periods may decrease the capability for water-based recreation at some reservoirs. Coordinating with reservoir and concession operators to adjust drawdown periods would minimize potential impacts to recreation in reservoirs participating in this proposed program.

No impacts to land use are expected as a result of the proposed program. Since fallowing is not a part of this program, no changes are expected to normal agricultural activities. Additionally, no impacts to wetlands are expected, since water use would remain normal under the program, as would routine practices of drainage water reuse in the Sacramento Valley.

This document identifies a number of other programs and projects that could potentially have a significant cumulative impact on the environment. If implemented during the life of the proposed Supplemental Water Purchase Program, these programs, including the Interim South Delta Program, CALFED Bay/Delta Program, Monterey Agreement, and Los Vaqueros, are not expected to result in significant cumulative impacts on the environment.

A number of alternatives to the proposed program were examined for feasibility, meeting program objectives, and minimizing signifi-

cant impacts on the environment. The alternatives analyzed include: No Supplemental Water Purchase Program (No Project); Supplemental Water Purchases of Only Surface Water Supplies; Agricultural Fallowing and Crop Substitution; and Increased Water Conservation and Demand Reduction Activities. A number of other projects were identified as potential alternatives but were determined to be infeasible for implementation within the term of this proposed program.

Table S-1
SUMMARY OF POTENTIAL IMPACTS AND PROGRAMWIDE MITIGATION
FOR THE
SUPPLEMENTAL WATER PURCHASE PROGRAM

Issue or Activity	Potential Impacts	Programwide Mitigation
Delta Water Quality	Salinity intrusion from prolonged reverse flows.	Purchase additional carriage water to be allocated for Delta outflow.
Delta Inflow Reductions	Upstream reservoir refill reduces Delta inflow, resulting in curtailed SWP/CVP pumping to maintain required Delta outflow.	Provide "refill criteria" mandating sellers to schedule reservoir refilling during times of excess Delta flows, including accounting procedures.
Delta Fish Losses	Entrainment losses of delta smelt, striped bass, winter-run chinook, or other fishes.	(1) Monitor entrainment and curtail pumping when required by existing laws and regulations. (2) Schedule water transfers during July through October to minimize fish mortality. (3) Pay for direct losses. (4) Monitor Delta water quality and flow indices and regulate pumping to maintain suitable conditions according to Water Quality Control Plan. (5) Coordinate reregulation of upstream reservoirs to improve flows in summer and fall.
Anadromous Fish	(1) Reduced streamflow dewaters redds. (2) High water temperatures at critical life stages increase mortality. (3) High flows in the wrong season or location attract spawning fish to unsuitable channels. (4) Disjointed water management in major tributaries adversely affects major river systems.	(1) Specify reservoir retention to ensure adequate seasonal supplies. (2) Develop release schedules for reservoir operations that optimize downstream temperature. (3) Time releases to avoid adversely attracting spawning runs. (4) When useful, install migration barriers in secondary streams. (5) To optimize conditions in the Sacramento and San Joaquin river systems, coordinate management of their tributaries with the U.S. Bureau of Reclamation. (6) Coordinated with CALFED Operations Group.
Lake and Tributary Stream Aquatic Resources	Low flows reduce aquatic organisms' reproduction and/or increase mortality.	(1) Coordinate reservoir release schedules with the Department of Fish and Game and sellers. (2) Time reservoir releases to maximize instream flows during critical periods in spring and fall. (3) Coordinate between various water districts affecting major tributaries, such as the Don Pedro TAC for the Tuolumne and others on the Stanislaus and Merced rivers.

Table S-1 *(continued)*
SUMMARY OF POTENTIAL IMPACTS AND PROGRAMWIDE MITIGATION FOR THE SUPPLEMENTAL WATER PURCHASE PROGRAM

Issue or Activity	Potential Impacts	Programwide Mitigation
Decreased Reservoir Carryover Storage	Cumulatively decreasing water quality, increasing water temperature, declining fish habitat, and less water for subsequent dry years.	In water transfer contracts, specify refill criteria to replenish water storage before making additional transfers. Limit transfer quantity to maintain adequate supply for subsequent dry periods.
Reduced Water Recreation Opportunities	Higher summer releases lower lakes below levels suitable for boating or reduce downstream flows in summer.	Spread water transfers over summer to minimize early drawdown and low summer flows, and when possible make releases for transfers after Labor Day.
Land Use Changes	Reduction of agricultural land base or other adverse changes in supplying regions.	Monitor land and water use in supplying regions to identify significant changes. If detected, modify the Supplemental Water Purchase Program.
Agricultural Wetlands	Reduced area or change in seasonal availability.	(1) Set up contracts to discourage reductions of agricultural water use in supply regions. (2) Schedule groundwater substitutions before October to accommodate fall flooding of fields for waterfowl.
Groundwater Substitution	Groundwater overdraft in regional watersheds.	Avoid groundwater substitution in areas where groundwater overdraft exists.
	Lowering of groundwater levels in adjacent wells.	(1) Space participating wells at least ½-mile apart. (2) Monitor groundwater levels in selected wells. (3) If necessary, shift or terminate pumping.
	Adverse changes in groundwater quality.	(1) Monitor water quality. (2) Shift or reduce pumping.
	Land subsidence in selling region.	(1) Establish a gridwork of extensometers in suspected problem areas. Take simultaneous readings of groundwater depth and land surface elevation. (2) If subsidence occurs, reduce pumping or modify groundwater pumping locations.

CONTENTS

Appendixes

Tables

Figures

Exhibit A

Sidebars

Chapter 1
INTRODUCTION

Over the past two decades or so, some areas of California have had periods when water supplies were inadequate. This was especially true during the 1987-1992 drought. Based on experience gained during the drought, there is a need for a program that would allow transfers of supplemental water supplies to some or all of the 29 State Water Project contractors during periods of water shortage. The State Water Project contractors are under contract with the Department of Water Resources to receive a long-term water supply. This program environmental impact report describes a proposed Supplemental Water Purchase Program designed to be in effect for 6 years and would be implemented only in years during which the Department was unable to deliver enough State Water Project water to meet contract entitlement requests.

The Department of Water Resources has prepared this program environmental impact report to address the possible impacts on the environment that might occur with the proposed Supplemental Water Purchase Program. To the degree possible, all potentially significant impacts and a number of programwide mitigation measures are identified that would be implemented to avoid or minimize significant adverse impacts. Some potentially unavoidable and irreversible impacts are identified as well. Implementation of the Supplemental Water Purchase Program will depend on a variety of factors, including level of water demand, restrictions to protect threatened and endangered species, and hydrologic and reservoir storage conditions. Due to uncertainties in the actual amounts of water to be transferred, areas from which water might be transferred, and areas that might receive the supplemental water, it is difficult to address all environmental impacts before implementation of the program.

Therefore, in accordance with CEQA[1] Guidelines Section 15168 provisions for program EIRs, this document will be used for CEQA compliance for each water transfer under the proposed Supplemental Water Purchase Program. Before approving each transfer, a checklist will be used to determine whether all environmental impacts of the transfer have been addressed in this document and whether any new mitigation measures would be required. If, in using the checklist, it is found that not all environmental impacts are adequately discussed, supplemental documentation will be prepared in accordance with CEQA.

This environmental impact report will be considered by the Department of Water Resources and participating State Water Project contractors when they execute contracts to establish the Supplemental Water Purchase Program. The EIR will also be used to support actions before the State Water Resources Control Board in approving water transfers within its jurisdiction. It will be used by the Department of Fish and Game to evaluate proposed changes in reservoir flow release schedules

1 California Environmental Quality Act

and any changes in Delta pumping conditions. The report will also support decisions of water agencies and districts in approving water sales and purchases.

This environmental impact report is based on the best information available, including the State Drought Water Bank Program Environmental Impact Report[2] prepared for water transfers implemented during drought conditions. Future changes will undoubtedly be made in Delta water quality standards and other regulatory restrictions. Delta exports by the State Water Project and Central Valley Project will be governed by a combination of existing standards contained in Decision 1485[3], objectives under the 1995 Water Quality Control Plan[4], and operational restrictions imposed by the U.S. Fish and Wildlife Service, National Marine Fisheries Service, and California Department of Fish and Game to protect fish species listed under the Federal and State endangered species acts. These restrictions reduce potential adverse environmental impacts associated with transferring water across the Delta. Changes in any restrictions will be examined relative to information contained in this report, and re-analysis will be presented in a supplemental report if necessary.

The proposed Supplemental Water Purchase Program will comply with all applicable State and Federal laws and regulations, including the California Water Code, Fish and Game Code, Federal and State Endangered Species Acts, Clean Water Act, State Water Project permits, and agreements entered into by the Department of Water Resources.

2 Department of Water Resources. 1993. *State Drought Water Bank.* Program Environmental Impact Report. 210 pp and appendixes.
3 State Water Resources Control Board. 1978. *Water Right Decision 1485: Sacramento-San Joaquin Delta and Suisun Marsh.* This decision is now under review.
4 State Water Resources Control Board. 1995. *Water Quality Control Plan for the San Francisco Bay / Sacramento-San Joaquin Delta Estuary.*

Chapter 2

DESCRIPTION OF THE PROPOSED PROGRAM AND RELATED ACTIVITIES

The objective of the proposed Supplemental Water Purchase Program is to supply additional water to participating SWP contractors in years when the State Water Project is unable to deliver enough water to meet their maximum annual entitlement for the water year.[1] The program is intended to fill all or part of the shortfall between deliveries of entitlement water to the participating contractors and requests from those contractors up to their Table A entitlements for that year. (Annual entitlements are shown in Appendix A.) The program would operate in calendar years 1997 through 2002.

Under this proposed program, water will be transferred each year only to participating SWP contractors who execute a Supplemental Water Purchase Agreement and in amounts not exceeding shortfalls in their entitlement water deliveries. The participating agricultural and urban water contractors will use the transferred supplies for the same purposes that a normal water supply would have been used for, as set forth in DWR water right permits held on behalf of the State Water Project.

The supplemental water will be provided through options or direct purchase agreements, which will establish a contractual right for the Department of Water Resources to purchase water to be delivered to the participating SWP contractors. Acquired options can be exercised only in an amount up to the shortfall in entitlement. Details of the option arrangements, including the exercise of options, allocation procedures, payment obligations, and other details, will be set forth in separate agreements between the Department of Water Resources, individual participating water contractors, and sellers. Under a direct purchase agreement, sellers will agree to transfer a defined amount of water to the Supplemental Water Purchase Program during a specified period in applicable years and at a specified price each year for up to 6 years.

During this 6-year period, the Supplemental Water Purchase Program will seek to acquire water from willing sellers from areas of the State where water could be moved to and through State Water Project facilities, either directly from surface water supplies or by groundwater substitution. For reasons of practicality, the Department of Water Resources has limited the program to streams and river systems that are tributary to the Sacramento-San Joaquin Delta.

State Water Project facilities and service areas where SWP water is currently supplied are described in detail in Chapter 3. Physical and biological descriptions of those geographic areas from which water could likely be transferred under this program

1 Entitlement water is the amount of project water to be made available to a contractor during a given year at the delivery structures provided for each contractor under the terms of the water supply contract with the Department of Water Resources. "Maximum annual entitlements" are the maximum amount that will be made available in any one year under each contract.

and those areas to which water is likely to be transferred are also provided in Chapter 3 and Appendix B.

This program will primarily use existing water production and transport facilities. No new construction of facilities is contemplated, although it is possible that some minor construction (such as monitoring wells) may occur. Any such minor construction will be required to comply with CEQA and will be subject to all other regulatory requirements.

Transfers under this program will be developed and designed to not have any unreasonable effect on beneficial uses of water as described in Water Code Section 1727. Further, the Department of Water Resources will seek to avoid or minimize significant adverse environmental impacts as required by CEQA.

Potential Sources and Amounts of Water for the Proposed Program

Water acquired by the proposed Supplemental Water Purchase Program would come primarily from two sources. The first source is surplus surface water stored in reservoirs. The transfer of water stored under post-1914 appropriative water rights must be approved by the State Water Resources Control Board. Obtaining water stored under pre-1914 appropriative water rights does not require the Board's approval. In either case, a release schedule would be developed in consultation with the Department of Fish and Game, U.S. Fish and Wildlife Service, and National Marine Fisheries Service, as needed. Areas from which this program might acquire surface water include:

- The Sacramento River and tributaries, including the American, Yuba, and Feather rivers.
- The San Joaquin River and tributaries, including the Merced, Tuolumne, and Stanislaus rivers.

The second source is groundwater substitution, whereby part of a surface water supply would be replaced by locally pumping an equivalent amount of groundwater. Monitoring would be implemented to evaluate any effects of the program on the local groundwater basin. Contracts to acquire water through this alternative would require that pumping be reduced or curtailed to the extent that such pumping is identified as a source of significant degradation of groundwater levels or groundwater quality or is found to threaten land subsidence.

The maximum amount of water estimated to be available annually from willing sellers for transfer under the proposed Supplemental Water Purchase Program is about 400,000 acre-feet. This figure is derived largely from experience during the Drought Water Banks in 1991, 1992, and 1994. Based on these previous transfers, water available from surface water supplies is expected to range up to about 200,000 acre-feet, and water supplied through groundwater substitutions would likely produce a similar amount. Hydrologic conditions, delivery capability, costs, and other factors would influence the amount of water that could actually be transferred. Groundwater and surface water sources are discussed in Chapter 4.

Participant Guidelines and Implementation

The proposed Supplemental Water Purchase Program would involve transfer of water from willing sellers to participating SWP contractors only, with a possible exception described below. Water received by contractors from this program together with annual entitlements shall not exceed the maximum annual entitlement for contractors under their long-term water supply contracts with the Department of Water Resources. Details of amounts to be transferred, costs, and allocations will be spelled out in individual contracts between the Department of Water Resources and participating contractors. Specific measures would be developed for each water source to avoid or lessen local environmental impacts.

Over the past several years, California has coped with severe water shortage and drought conditions. During 1991, 1992, and 1994, the Department of Water Resources administered the Governor's emergency Drought Water Bank to meet critical water supply needs statewide. In developing the concepts of the Supplemental Water Purchase Program, a concern was raised about the possibility that the program would buy up all of the "cheap" water available. This would leave only the more expensive water available for the Drought Water Bank if it is formed and activated during the term of the Supplemental Water Purchase Program. It was feared that while the larger, more sophisticated water districts and government agencies could compete with the Supplemental Water Purchase Program for purchasing supplemental water, the smaller entities, without staff resources to negotiate with the water sellers, would have to rely solely on the Drought Water Bank for purchase of additional water supplies. To address this concern while recognizing the dual responsibilities of the Department of Water Resources to meet contractual obligations to the State Water Project contractors and administer the Drought Water Bank, it was decided that a portion of the Supplemental Water Purchase Program "option" water would be set aside to help meet the needs of the smaller entities. The amount of water made available to the Drought Water Bank in any year will be the lesser of the following:[2]

- 10 percent of the total amount of option water available to the Supplemental Water Purchase Program in the year the Drought Water Bank is formed and activated, or
- A defined maximum amount to be determined by an analysis of the needs of the "small contractor" participants in prior Drought Water Banks.

Drought Water Bank participants will reimburse the Supplemental Water Purchase Program for all costs associated with water made available to the Drought Water Bank.

2 Memorandum from Steve Macaulay, General Manager, State Water Contractors, to Douglas Wheeler, Secretary for Resources, dated June 18, 1996.

Delivery Pathways and Areas That May Receive Water

Most water transfers under the proposed Supplemental Water Purchase Program will go through the Sacramento-San Joaquin Delta. Water would be conveyed by the State Water Project and could be transferred west to Alameda, Solano, Napa, and Santa Clara counties; southwest to Santa Barbara and San Luis Obispo counties; or south to the San Joaquin Valley and Southern California. In addition, it is possible that State Water Project contractors north of the Delta may participate in the program.

Program Benefits

The proposed Supplemental Water Purchase Program is intended to augment water supplies when the Department of Water Resources is not able to meet all SWP contractors' entitlement requests. Water transfers to both urban and agricultural areas are expected to reduce environmental and economic losses during periods when contractor entitlements are less than 100 percent.

Agricultural area transfers may result in decreased economic losses and unemployment resulting from water shortages. The transfers could also reduce losses of wildlife habitat associated with agriculture. In addition, groundwater pumping, and in some cases overdrafting, may be reduced in agricultural receiving areas.

Many fish species are expected to benefit from greater instream flows. Although there could be minor impacts to some species as a result of increased exports, the overall impact to fish is expected to be beneficial, due to increased streamflows. The presence of four races of chinook salmon in Central Valley streams results in an extended period of emigration, but during July, August, and September, juvenile emigration through the lower river and Delta is near zero, probably because of low water levels and high temperatures. As a result of this lull in emigration, most water transfers under this program are likely to occur during July through October (emigration is generally low in October).

In addition to the potential environmental benefits, the proposed program will provide additional water supply benefits by fostering the development of water marketing contracts. Department of Water Resources experience with acquiring water from sellers has typically involved single-year contracts. The participating contractors expect that DWR will negotiate multi-year contracts that will contain provisions to transfer water in those drier years in which the contractors specify that a supplemental supply is required. Multi-year contracts should enhance the reliability of the contractors' water supplies because the water transfer agreements would be in place prior to a dry year and the risk associated with not acquiring the supply would be removed. Provisions that would allow the contractors to specify delivery of water in years when it is needed should enhance the cost-effectiveness of multi-year supplies, because the most significant portion of related payments are expected to be made only in years when water is delivered. This program would also provide participating sellers with a revenue source and will allow sellers to plan future operations related to water transfer activities. Further, the information gained with these types of sales agreements should provide valuable experience in determining the practicality of such agreements and their application toward future water marketing programs.

Legal Considerations

The California Legislature has established a policy to facilitate voluntary water transfers and has directed the Department of Water Resources, the State Water Resources Control Board, and all other State agencies to encourage voluntary water transfers.[3] Water rights of those transferring water are not impaired nor forfeited as a result of water transfers.[4] Water rights obtained outside the State water right permitting process can be transferred without approval by the State Water Resources Control Board. Pre-1914 appropriative rights can be transferred without SWRCB approval as long as there is no adverse effect on any other legal water user or the environment.[5] Transfers of groundwater do not require Board approval because the Board does not regulate rights to groundwater.

The State Water Resources Control Board can issue four major types of transfer approvals.

- A temporary 6-month urgency permit may be granted for a new diversion.[6]
- An urgency permit may be granted for a change to an existing diversion for up to 6 months.[7]
- A temporary change may be approved for a transfer that lasts 1 year or less and involves water that is consumptively used or stored.[8]
- Long-term transfers in excess of 1 year.

Approvals for all four categories require that the transfers do not harm existing rights and legal uses of water and have no unreasonable effects on fish, wildlife, or other beneficial uses. Temporary water transfers subject to State Water Resources Control Board approval under Water Code Section 1725 are exempt from CEQA and can be approved by the SWRCB without a hearing if legal water users are not injured and if fish, wildlife, or other instream beneficial uses are not unreasonably affected. However, the Board has determined that water transfers resulting in adverse impacts to upstream (outside of the Delta) areas could be significant; therefore, such transfers will not be approved unless an environmental assessment is prepared that adequately addresses potential fish impacts and other environmental effects of the project. Environmental analyses essentially meeting the requirements of CEQA may be necessary to allow the Board to make the required finding that there is no injury to any legal water user and that fish, wildlife, or other beneficial uses are not unreasonably affected.[9] Long-term transfers under Water Code Section 1735 and temporary urgency changes under Water Code Section 1435 require CEQA compliance.

The Legislature has enacted statutes limiting inter-basin water transfers to protect areas of origin. Counties and watersheds of origin and immediately adjacent areas that

3 California Water Code Sections 109 and 475.
4 California Water Code Sections 475, 1011, 1244, and 11961.
5 California Water Code Section 1706.
6 California Water Code Section 1425.
7 California Water Code Section 1435.
8 California Water Code Section 1725.
9 California Water Code Section 1727.

can be conveniently supplied receive priority over SWP and CVP water users.[10] Additional protection against exports pursuant to appropriations initiated after January 1, 1985, apply to the Sacramento, Mokelumne, Calaveras, and San Joaquin river systems and the Delta.[11] Reasonable consumptive uses in the Delta also receive priority under the Delta Protection Act of 1959.[12]

Several recent State laws also affect the proposed Supplemental Water Purchase Program. Water Code Section 1745 *et seq.* allows water suppliers to transfer water out of their service areas without a finding that the water is surplus to their needs. It protects the water rights of the transferor by reaffirming that a water transfer made pursuant to provisions of the bill is deemed to be a beneficial use of water. It limits annual transfers from a water supplier to 20 percent of the total available unless, following reasonable notice and a public hearing, the supplier approves a larger percentage. Finally, the law imposes restrictions on transfers involving groundwater:

> *A water user that transfers surface water pursuant to this article may not replace that water with groundwater unless the groundwater use is either of the following: (a) consistent with a groundwater management plan adopted pursuant to State law for the affected area; (b) approved by the water supplier from whose service area the water is to be transferred and that water supplier, if a groundwater management plan has not been adopted, determines that the transfer will not create, or contribute to, conditions of long-term overdraft in the affected ground water basin.*
> *[Water Code Section 1745.10]*

These changes in State law are intended to reduce potential impacts of water transfers to the local economy, as well as reduce potential impacts to regional groundwater resources. Future water transfers will accommodate these policy concerns.

Water Code Section 10750 *et seq.* provides new authority to water districts and other water suppliers to develop groundwater management plans within their service areas but does not *require* that plans be developed. However, groundwater management plans developed pursuant to this law fit into requirements of Water Code Section 1745.10, cited above.

In June 1987, the State Water Resources Control Board began hearings to establish a water right decision to replace Decision 1485, which currently places terms and conditions on the State Water Project and Central Valley Project for protection of Delta beneficial uses. Also, as part of an April 1992 water policy statement, the Governor asked the Board to develop interim standards to further protect fishery resources of the Bay/Delta estuary. In March 1993, the Board held a public workshop to discuss interrelationships between Delta standards in draft Decision 1630 and Federal Endangered Species Act restrictions. At that workshop, Federal fisheries officials said current and proposed endangered species act restrictions would build on the standards proposed in draft Decision 1630 and that from 1 million to 3 million acre-feet of additional Delta outflow might be required above the draft Decision 1630 standards.

10 California Water Code Sections 10505 and 11460.
11 California Water Code Section 1215.
12 California Water Code Sections 12200-12220.

In response to the regulatory uncertainty brought on by current and proposed endangered species act restrictions, the Governor wrote to the State Water Resources Control Board in April 1993 asking the Board to defer action on interim Delta standards and redirect efforts toward establishing permanent Delta standards. The Governor's letter indicated that the need for interim standards no longer existed, since for all practical purposes such interim protection was being provided by the U.S. Fish and Wildlife Service and National Marine Fisheries Service pursuant to the endangered species act. The Governor encouraged the Board to continue the process of developing permanent standards for the Delta.

By notice dated April 22, 1993, the State Water Resources Control Board stated that it would not consider adopting Decision 1630 as an interim measure and would not adopt an interim water right decision regarding Delta water quality standards until it had prepared an environmental impact report and conducted further hearings. In its notice, the Board indicated that a combination of endangered species restrictions and above-normal runoff in 1993 would help protect fish during the spring, when they are most vulnerable to flow reductions.

The need for permanent standards in the Delta, as recognized by water users and environmental groups alike, has since been pursued by establishing the CALFED Framework Agreement, described below.

CALFED Framework Agreement for the Bay/Delta Estuary

In mid-1994, the State and Federal governments signed a memorandum of agreement for a comprehensive program for interagency cooperation and communication in management of the Bay/Delta estuary system to provide for both dependable water supplies and environmental protection. Agencies that form the Governor's Water Policy Council and agencies in the Federal Ecosystem Directorate are parties to this "CALFED Framework Agreement".

Specific goals of the agreement are to improve coordination of water supply operations with endangered species protection and compliance with water quality standards and to develop long-term solutions to fish and wildlife, water supply reliability, flood control, and water quality problems in the estuary.

Through the CALFED process, the State and Federal governments, a group representing urban and agricultural water users, and environmental groups have agreed on interim Bay/Delta standards. This process has resulted in adoption of *Principles for Agreement on Bay/Delta Standards Between the State of California and the Federal Government.*[13] The agreement incorporates water quality standards for the Bay and Delta adopted by EPA in December, in accordance with Federal law. Coincidentally with announcement of this agreement on December 15, 1994, the State Water

13 Agreement signed December 15, 1994, by the Secretary, California Resources Agency; Secretary for Environmental Protection, California Environmental Protection Agency; Secretary of the Interior; Secretary of Commerce; and Administrator, U.S. Environmental Protection Agency.

Resources Control Board released its draft Water Quality Control Plan[14], which contains the same provisions as those in the agreement. The Water Quality Control Plan, adopted in May 1995 after a series of public workshops, is designed to restore and protect the aquatic environment and minimize water supply impacts on agricultural and urban users of fresh water flowing into the Delta. CALFED agencies have pledged to coordinate water project operations to meet these interim water quality standards as well as current requirements of both the Endangered Species Act and Central Valley Project Improvement Act, through the CALFED Operations Group.

As part of the Bay/Delta agreement, the U.S. Environmental Protection Agency withdrew federally-mandated water quality standards in support of the Water Quality Control Plan. After 3 years, the Water Quality Control Plan will be reviewed and modified if necessary. Implementation of the Water Quality Control Plan is being addressed through the State Board's water right process. When that process is complete, provisions that pertain to the Delta and to operation of the State Water Project will supersede Decision 1485. In the meantime, the Department of Water Resources has agreed to operate the State Water Project in accordance with provisions in the Water Quality Control Plan.

Federal and State leaders and water managers expect these agreements to stimulate formation and approval of a fair, long-term water use plan that will guide State Water Project and Central Valley Project export activities into the twenty-first century. The CALFED Bay-Delta Program, a major element of the Framework Agreement, is dedicated to finding long-term solutions to fish, wildlife, water supply reliability, water quality, and levee stability concerns in the San Francisco Bay and Delta area. The Bay-Delta Advisory Council, a group of more than 30 advisors representing urban, agricultural, environmental, business, fishing, and other interests concerned with the long-term viability of the estuary, advise CALFED about problems to be addressed. The Bay-Delta Advisory Council is a forum to help assure wide public participation in drafting a workable, long-term water use plan for the Bay/Delta estuary. The Bay/Delta Agreement resulted in formation of a CALFED operations group, in which project operators and fish managers meet as needed to adjust project operations to help protect fish and ensure water supply reliability.

The Department of Water Resources is a CALFED partner and will provide information to CALFED about the proposed Supplemental Water Purchase Program as necessary to meet its commitment to coordinate and cooperate.

Operational Constraints

Several operational constraints could affect water transfers under the proposed Supplemental Water Purchase Program. Depending on hydrologic conditions, these constraints determine how much, if any, water can be moved through the Delta as well as when it can be transferred, exported, and delivered. Constraints can be described in four groups: U.S. Army Corps of Engineers criteria, water quality,

14 State Water Resources Control Board. 1994. *Draft Water Quality Control Plan for the San Francisco Bay / Sacramento-San Joaquin Delta Estuary.*

outflow, and inflow/export ratio. Under all constraints, basic project/entitlement water is moved first; if any room is left, transfer water under this proposed program is moved.

The ability of the Department of Water Resources to pump water at Harvey O. Banks Delta Pumping Plant is limited by the amount of water available in Clifton Court Forebay. To comply with the U.S. Army Corps of Engineers' administration of Section 10 of the Rivers and Harbors Act of 1899[15], the Department limits diversion of water from Delta channels into Clifton Court Forebay to 13,870 acre-feet in any one day and 13,250 acre-feet average daily diversion over a 3-day period. The exception is that between December 15 and March 15, if San Joaquin River flow at Vernalis exceeds 1,000 cfs, the Department may divert one-third of Vernalis flow in addition to the normal daily limit. It is unlikely that the intake limitation would be a constraining factor in critical years due to low flows, when demands for program flows would be at a maximum.

Another constraint is pumping capability at Banks Pumping Plant. Planned and unplanned outages of pumping units for maintenance or repair, limitations at John E. Skinner Fish Protective Facility, or limitations on aqueduct conveyance capability can have a major impact on the ability to move purchased water. Entitlement and program water will have priority for use of available capability.

Many specific water quality standards must be met as a condition of the water right permits for the State Water Project and Central Valley Project. Theoretically, moving transfer or purchased water will not impact Delta water quality because it will have an associated "carriage water" component that goes to increased Delta outflow. In reality, the State Water Project and Central Valley Project operate in real time, monitoring water quality and reacting with changes in reservoir releases to the rivers supplying the Delta and changes in export pumping from the Delta. If SWP export pumping must be reduced, the available pumping capacity will be allocated first to SWP contractors and then to non-SWP entities.

Carriage Water

Carriage water is the incremental amount of Delta outflow needed to prevent salinity intrusion due to prolonged reverse flows and resulting impacts on water quality. It is required of any water transferred through the Delta.

For the 1991 and 1992 Drought Water Banks, a carriage water factor was calculated based on the source of the water. In 1991, a negotiated "melded" rate of 14 percent was used, based on internal Delta transfers with a requirement of zero and transfers across or through the Delta with a requirement of 20 percent. In 1992, a requirement of 20 percent was applied to all transfers because they all went through the Delta. For the 1994 Drought Water Bank, a 20 percent requirement was applied to all transfers (except one in the southern Delta), resulting in about 178,000 acre-feet of actual exports out of about 222,000 acre-feet actually purchased.

15 33 U.S.C. Section 403.

The 1995 Water Quality Control Plan for the Bay/Delta contains a new limitation on exports during July through October in the form of an export/inflow ratio of 65 percent[16]. This export ratio could be the real constraint, since the window for moving project water across the Delta has been pushed into this same period. The ratio does not in itself limit transfers, but it automatically applies a maximum carriage water requirement of 35 percent for transfers across or through the Delta from either the Sacramento or San Joaquin side (if total SWP/CVP pumping is at the limit). Also, the ratio calculation as now proposed does not recognize internal Delta transfers (that is, where the source of water for a transfer originates in the Delta); therefore, if the ratio is the control for the day, any internal Delta transfers may be eliminated for that day. In the past, the SWP and CVP had some discretion to modify assumptions of internal Delta channel depletions to accommodate internal transfers, but it is not clear if that discretion still exists under the Principles for Agreement on Bay/Delta Standards.

The State Water Resources Control Board staff has determined that as long as water transfers meet the Water Quality Control Plan criteria, there will be no unreasonable environmental impacts to fish, wildlife, or other beneficial uses in the Delta during July through October. According to the 1995 Water Quality Control Plan environmental report, model results predict that implementing the proposed standards should at least maintain abundance of the modeled aquatic resources except striped bass during July-October. Although fish and wildlife agencies and many environmental groups endorsed the Water Quality Control Plan as an interim measure, many of them do not believe the standards adequately protect biological resources for the long-term and, therefore, would like to see a longer-term plan developed that addresses water transfers. Discussions are underway to address the concerns of these groups regarding water transfers through the Delta.

Historically, carriage water was assessed for water transfers made from the Sacramento basin. This additional outflow was needed to cancel the effect of incremental export increases when the Central Valley Project and State Water Project are operating to Delta water quality standards. The 1995 Water Quality Control Plan and the December 15 Accord contain other requirements that may affect project operations, such as Delta outflow or the export/inflow ratio. Still, carriage water may be required even though the controlling standard is not water quality. For instance, outflow may have to be maintained at a level higher than the minimum to keep from drawing salinity from the western Delta into the interior. If the export/inflow ratio is controlling, there would be an automatic carriage water assessment of 35 percent during the times of the year for which Supplemental Water Purchase Program transfers are envisioned. Transfers of water from the San Joaquin River system could remain free of carriage water requirements except as necessitated by the export/inflow ratio. Transfers from the southern Delta could continue to enjoy the zero carriage water requirement if it can be demonstrated that actual channel depletions will be reduced when the water transfer is made and will not be increased later and assuming the export/inflow ratio is not controlling.

16 During this period, combined SWP/CVP exports can be no more than 65 percent of the total inflow to the Delta.

Although not specifically an operational constraint, previous Drought Water Bank transfers from the San Joaquin River system have been assessed a transportation/conveyance surcharge. In 1991, all transfers from the San Joaquin system were assessed a 10 percent water loss surcharge. Transfers from the San Joaquin system under the proposed Supplemental Water Purchase Program may be assessed a transportation/conveyance surcharge, as determined in coordination with the U.S. Bureau of Reclamation,which would be identified in the contracts between the Department of Water Resources and the sellers/buyers.

The Department of Water Resources and Department of Fish and Game have an agreement regarding Feather River flow and water temperature. The need to maintain enough flow to keep cool water moving in the river must be balanced against the need to maintain enough water in Lake Oroville to allow cooler water to be released from the depths of the reservoir in the fall. In some cases, this constraint might improve the ability to transfer purchased water, but it could impact operations in cases where water is purchased within the Lake Oroville service area and shifted in time by using Lake Oroville's storage.

Related Activities

Other activities that may affect the proposed Supplemental Water Purchase Program include possible implementation of Drought Water Banks; coordination with local water authorities to buy, sell, or trade water in this program; and interaction with Federal water programs developed for the Central Valley Project Improvement Act. Recent experience related to these activities illustrates the complexity of a water transfer program in California.

Drought Water Banks

In 1991, 1992, and 1994, the Governor created Drought Water Banks to meet critical water needs. Each Water Bank is described briefly below. More detailed descriptions are available in the environmental impact report for the Drought Water Bank[17] and are incorporated by reference into this document. The basic water balance of the Water Banks shown in Table 1 was developed from records of the State Water Project Operations Control Office.

The 1991 Drought Water Bank, the first of its kind, was implemented in February 1991 against a backdrop of unmet water demand in excess of 800,000 acre-feet and projected severe local shortages. Water was developed through reservoir storage purchases, groundwater substitution arrangements, and fallowing farm land. Substantial measures were taken to protect and provide additional benefits to fish and wildlife. The Department of Fish and Game acquired some 40,000 acre-feet of water through transfers related to the Water Bank. In addition, substantial reregulation of Shasta, Oroville, Folsom, and Bullards Bar reservoirs resulted in improved streamflow for fish.

17 Department of Water Resources. 1993. *State Drought Water Bank.* Program Environmental Impact Report. 210 pp and appendixes.

Table 1
WATER BALANCE OF DROUGHT WATER BANKS
(In Acre-Feet, Rounded)

	Water Bank Amount		
	1991	1992	1994
Water Source			
Fallowing[1]	390,000	0	0
Groundwater[1]	285,000	161,000	189,000
Surface Water	145,000	32,000	33,000
Total Purchased	820,000	193,000	222,000
Delta Requirements[2]			
Carriage Water	107,000	34,000	44,000
Technical Adjustments	58,000	0	0
Net Available	655,000	159,000	178,000
Allocations			
Urban Uses	307,000	39,000	24,000
Agricultural Uses	83,000	95,000	154,000
Wildlife Uses	0[3]	25,000	0
Total Used	390,000	159,000	178,000
Carryover Storage	265,000	0	0
Total Allocated	655,000	159,000	178,000

1 Amounts for fallowing and groundwater shown for 1991 are those agreed to by the SWP and CVP as part of the Coordinated Operation Agreement. One large purchase, included entirely in the groundwater category, also included some fallowed acreage. If this had been accounted for in the fallowing category, the fallowing amount would be about 25,000 acre-feet greater and the groundwater amount would be about 25,000 acre-feet less. There would be no change in availability of the water at the Delta, however, since this was a transfer from a CVP water supply contractor and was provided by the CVP in the Delta when it was needed.

2 Water required to remain in the Delta for water quality protection and miscellaneous technical corrections.

3 More than 40,000 acre-feet of water was provided in transactions related to the Drought Water Bank.

The 1991 Water Bank purchased about 820,000 acre-feet of water. These supplies were exported from Butte, Colusa, Contra Costa, Sacramento, San Joaquin, Shasta, Solano, Stanislaus, Sutter, Tehama, Yolo, and Yuba counties. Kern, Fresno, and Stanislaus counties imported about 80,000 acre-feet for agricultural use. Alameda, Contra Costa, Los Angeles, San Francisco, and Santa Clara counties imported about 310,000 acre-feet for urban use. The remaining 430,000 acre-feet was used as carriage water, carryover storage, or technical adjustments (Table 1).

The fallowing component of the 1991 Drought Water Bank encompassed 160,000 to 170,000 acres. Of this, 130,000 acres were not planted; the rest was already planted but was denied further irrigation. Due to record rainfall in March 1991, substantial crop production was realized from much of this acreage.

The 1992 Drought Water Bank was implemented under less severe drought conditions than 1991, with substantially lower water demand. No land was fallowed under the 1992 program. Transfer of water through the Delta began in July at the CVP Tracy Pumping Plant. Both Banks Pumping Plant and Tracy Pumping Plant exported Drought Water Bank water in August, September, and October. By borrowing from water stored in San Luis Reservoir, some SWP contractors received 1992 Water Bank deliveries before actual pumping from the Delta. Water wheeled for the City and County of San Francisco was pumped and stored in San Luis in August and September in exchange for delivery during October, November, and December. A fundamental

scheduling strategy was to minimize impacts on winter-run chinook salmon, delta smelt, and striped bass, and to complete the majority of the transfer before October 31 to minimize disruption to normal SWP and CVP pumping operations during November and December. An additional dollar per acre-foot charged to buyers went to the Department of Fish and Game for fish and wildlife mitigation.

The 1994 Drought Water Bank resulted in the purchase of about 220,000 acre-feet from 13 sellers to meet critical needs of 15 buyers. Of this, only 2,500 acre-feet was purchased from Delta sources (East Contra Costa Irrigation District). The rest came from sources north of the Delta. About 85 percent (186,800 acre-feet) of water purchased came from agricultural users through groundwater substitution and surface water reduction arrangements. The other 15 percent (33,000 acre-feet) was acquired through supplemental reservoir releases. About 20 percent (43,500 acre-feet) of the purchased water was provided as carriage water and increased the Delta Outflow Index during the transfer period.

Most of the 178,000 acre-feet (total water purchased less carriage water) was exported from the Delta during mid-August through mid-October, except for brief periods when export pumping was curtailed to maintain water quality standards. Water exports peaked during the last two weeks of August through the first two weeks of September. The 1994 Water Bank exports were scheduled to minimize adverse impacts to fish species such as delta smelt, winter-run chinook salmon, splittail, and striped bass.

Specific measures to mitigate for impacts to the Delta fishery or to avoid impacts to the endangered winter-run chinook salmon included reregulating reservoirs and pumping most of the transferred water through the Delta in August through October. Yuba County Water Agency, which transferred 24,000 acre-feet to the Water Bank, released an additional 12,000 acre-feet from New Bullards Bar Reservoir to prevent dewatering of salmon redds. To mitigate for incremental increases in projected losses at Banks Pumping Plant, the State Water Project funded the acquisition and planting of 300,000 striped bass fingerlings.

In anticipation of a second consecutive dry year, the Department of Water Resources organized the 1995 Drought Water Bank program in September 1994. By November, 14 water agencies had signed contracts to purchase water from the Water Bank if needed to meet critical needs. The Department then formed the Water Bank in an inactive status that could be activated if 1995 was critically dry.

While in an inactive status, the Department of Water Resources purchased options on 29,050 acre-feet of water for the Bank from five sellers. Under terms of the option contracts, the Department of Water Resources could pay sellers an exercise fee by May 1995 and take possession of their water or forfeit the option payments. As a result of abundant precipitation and snowpack throughout California in 1995, the Department of Water Resources did not exercise the options.

Coordination of Water Transfers with Local Entities

Some key examples of coordination with local entities are Drought Water Bank transfers in Yolo and Butte counties. In February 1991, the Yolo County Board of Supervisors adopted a memorandum of understanding with a large water user who

proposed to transfer water during 1991. The MOU set forth monitoring requirements, a coordination process, and payments to Yolo County to reimburse costs and contribute to an update of the County Water Plan. That water user eventually participated in the Water Bank, and the Department of Water Resources agreed to the terms and conditions of the MOU. That process became the foundation of subsequent Water Bank contracts in the county involving groundwater substitutions. In addition, DWR staff met frequently with local officials to keep them up to date on water transfer activities. A Technical Advisory Committee of local water officials was formed to review the results of a comprehensive groundwater monitoring program established to measure impacts of water sales. The monitoring program itself was established with substantial involvement by the county's water consultant. Coordination in Yolo County increased in 1992, and the Technical Advisory Committee became an active forum to discuss a wide range of local water resource concerns.

Local coordination within Butte County has taken a somewhat different course. During the 1991 Water Bank, Butte County and the Department of Water Resources executed an agreement calling for direct payment to the county of 2 percent of the gross proceeds paid for transfers of water from Butte County under groundwater substitution contracts. Butte County agreed to use these funds for monitoring and study of water conditions and for development of a water management plan. The county subsequently joined with local water interests to form Butte Basin Water Users Association, which soon sponsored a major groundwater modeling and water management planning effort. The 1991 Butte County agreement also provided for DWR to share the results of its intense groundwater monitoring with the county on a timely basis. Similar agreements continued the 2 percent payment and other terms of the original agreement during the 1992 and 1994 Water Banks.

The Department of Water Resources executed another agreement in the fall of 1991 to guarantee adequate fall water supplies for waterfowl in the Butte Sink area and to assure their effective management. This "Five-Party Agreement" involved Western Canal Water District, Butte Sink Waterfowl Association, U.S. Fish and Wildlife Service, Department of Fish and Game, and Department of Water Resources. The Five-Party Agreement laid the groundwork for subsequent arrangements that have prevented detrimental impacts of water transfer activities on downstream waterfowl resources.

Two other transfers of stored water in 1992 resulted in substantial local benefits. The first was a transfer of water from South San Joaquin Irrigation District and Oakdale Irrigation District. Both districts divert water from the Stanislaus River. The boards of these districts required that local benefits to the fisheries and Delta agriculture be a part of the transfers. The districts initiated discussions with the Department of Fish and Game, U.S. Bureau of Reclamation, Western Area Power Administration (concerning potential impacts to New Melones Reservoir power generation), and South Delta Water Agency. The resulting transfers provided additional benefits to the Stanislaus River fishery and Delta agriculture and transferred about 50,000 acre-feet to the Water Bank. The second transfer involved a sale of about 12,000 acre-feet from Merced Irrigation District to the Water Bank. The district took a similar position to the one taken by the districts on the Stanislaus River. Merced Irrigation District worked closely with the Department of Fish and Game to release the transferred water on a schedule that would benefit migrating salmon in the Merced and San Joaquin rivers.

A 1994 Water Bank purchase from Placer County Water Agency was closely coordinated with the Department of Fish and Game and U.S. Bureau of Reclamation to maximize local benefits as part of the transfer. Placer County Water Agency released a total of 20,000 acre-feet from French Meadows and Hell Hole reservoirs during September, October, and November. The water flowed through the Middle Fork American River power house and then into Folsom Lake, where the Drought Water Bank took delivery. The water was then released through Folsom Dam to the American River, thence the Sacramento River and the Delta. To export the equivalent of the transferred water during September and October, when exports from the southern Delta would have little or no adverse effect on endangered fish species, the Department of Water Resources released water from Lake Oroville during September, which was exchanged for the Placer County water released in November. The Drought Water Bank released Placer County water from Folsom Lake during October and November to improve salmon spawning in the lower American River. The water released in November was also used for Delta outflow and other Delta requirements and was not exported from the Delta.

Sacramento Valley Conjunctive Use

The Department of Water Resources continues its investigation, started in 1992, of the potential for conjunctive use of surface water and groundwater in the Sacramento Valley. Water obtained through conjunctive use projects in the Sacramento Valley may be used to augment the State Water Project supply. The Department has adopted a three-part approach to its investigation:

- Conduct prefeasibility investigations and develop demonstration programs to allow incremental expansion as conditions allow.
- Evaluate water supply and hydrogeologic conditions, existing facilities, legal and institutional relationships, and existing operations.
- Work with local agencies to establish cooperative relationships needed to effectively resolve legal and institutional concerns.

Prefeasibility Studies and Demonstration Projects

The Department of Water Resources has completed a cooperative prefeasibility investigation in eastern Yolo County for a proposed groundwater recharge project that would recharge groundwater basins during wet years for extraction during dry years. This operation would add about 30,000 acre-feet to the State Water Project for delivery in dry years. The Department is working with land owners to develop a 3- to 5-year demonstration program.

The Department has completed prefeasibility investigations in the basins of the American and Bear rivers in Sutter, Placer, and northern Sacramento counties and is conducting feasibility-level investigations. These investigations contemplate development of 45,000 to 55,000 acre-feet of dry year water supply for the State Water Project. The water would be developed by substituting surface water for groundwater in wet years, which would allow additional water to go into aquifer storage. This work is expected to proceed to a more detailed feasibility study.

In Butte County, work is continuing at the M&T Chico Ranch — evaluating the hydrogeology of the ranch, developing a water level monitoring network, reviewing water rights, identifying recharge options, and examining recharge and extraction options. This study should be completed in 1996.

Resource Inventory

The Department of Water Resources has reviewed existing information on hydrogeologic conditions, water supply and use, facilities, and operations in the Sacramento Valley. Types of information evaluated included:

- Historical water level changes.
- Well yields and specific capacity.
- Base of fresh water.
- Number and types of wells.
- Recharge suitability.
- Groundwater quality.
- Drought Water Bank participation.
- Potential land subsidence.
- Intensity of groundwater use.
- Water supply and source.
- Availability of conveyance facilities.

On the basis of this information, seven areas (covering the valley) were identified in which conditions, operations, and historical patterns of development (including the extent of conjunctive operation by local agencies) are similar. Continuing efforts are directed toward identifying areas in which it may be possible to increase local and regional water supply reliability, assist in solving local problems such as alleviating land subsidence, and develop additional water for use by the State Water Project without harming local interests.

Legal and Institutional Environment

The legal and institutional environment governing development of conjunctive use projects is an increasingly complex maze that must be negotiated. The Department of Water Resources is seeking to work cooperatively with local interests as they develop groundwater management plans, contemplate local regulation of water exports, and seek solutions to water and environmental management problems. The Department of Water Resources expects that it will be able to develop conjunctive use projects that accommodate local concerns.

Central Valley Project Improvement Act

The Central Valley Project Improvement Act[18] has far-reaching implications with regard to water transfers in California. The law represents a major revision to the Federal law governing the Central Valley Project. A major portion of the Central Valley Project Improvement Act deals specifically with water transfers. The Act encourages transfers and allows transfers of CVP water out of a service area. The U.S. Bureau of Reclamation has developed interim guidelines to carry out provisions of the law. The water transfer provisions apply to "... *all individuals or districts who receive Central Valley Project water under water service or repayment contracts, water rights settlement contracts or exchange contracts* ..." [Section 3405(a)].

There are many uncertainties with the Central Valley Project Improvement Act, including its applicability to so-called "base supply[19]". Water purchased for the Water Bank from CVP contractors in 1991, 1992, and 1994 was limited to base supply. In any event, specific rules apply to transfers that are deemed to fall within the Act. The rules that have relevance to the Supplemental Water Purchase Program include requirements that:

- All transfers made pursuant to the Central Valley Project Improvement Act comply with State law, including CEQA.
- Transfers are subject to a right of first refusal for 90 days (from the date of intent to transfer) by other water users within the CVP service area.
- The Secretary of Interior shall review and approve all transfers for compliance with the Central Valley Project Improvement Act within 90 days of receipt of a completed application for a transfer; if the Secretary does not take action within the 90 days, the transfer is deemed approved.
- The Secretary shall not approve any transfer unless the Secretary determines that it would have no significant long-term adverse impact on groundwater conditions in the seller's area.
- The Secretary shall not approve any transfer that:

  "... *would result in a significant reduction in the quantity or decrease in the quality of water supplies currently used for fish and wildlife purposes, unless the Secretary determines pursuant to findings setting forth the basis for such determination that such adverse effects would be more than offset by the benefits of the proposed transfer; in the event of such a determination, the Secretary shall develop and implement alternative measures and mitigation activities as integral and concurrent elements of any such transfer to provide fish and wildlife benefits substantially equivalent to those lost as a consequence of such transfer ...*" *[Section 3405(a)(1)(L)]*.

- The Secretary shall not approve any transfer that might otherwise limit the Secretary's ability to meet CVP contractual or fish and wildlife obligations by displacing canal conveyance and/or pumping capacity.

18 PL. No. 102-575, Title 34, 106 Stat. 4706 (1992).

19 Base supply is that component of a Central Valley Project water right settlement contract that represents the amount of water associated with a pre-existing water right held by the water user.

- Any transfer involving more than 20 percent of a selling district's water supply shall be subject to review via public notice and hearing as well as to approval by the district.

There are still uncertainties for transfers involving base supply. Guidelines for those transfers are being formulated by the Federal Government.

Additional environmental purposes of the Central Valley Project Improvement Act are to protect, restore, and enhance fish, wildlife, and associated habitats in the Central Valley and Trinity River basins and to contribute to California's interim and long-term efforts to protect San Francisco Bay and the Sacramento-San Joaquin Delta. Section 3406 includes the following major topics that are pertinent to the proposed program.

- The CVPIA amends the original 1937 legislation authorizing the Central Valley Project to include as a project purpose the mitigation of fish and wildlife losses incurred as a result of construction, operation, or maintenance of the Central Valley Project, based on the replacement of ecologically equivalent habitat. However, this process is subject to other provisions of the CVPIA and possible future project actions that may adversely affect fish and wildlife populations or their habitat. [Section 3406 (a)(3)].
- The CVPIA directs that the Central Valley Project be operated to meet all legal obligations for fish and wildlife restoration under the Endangered Species Act and Clean Water Act. In addition, it requires development of a program to restore sustained natural production of anadromous fish to "levels not less than twice the average levels attained during the period of 1967-1991". This clause has been dubbed the "fish doubling" provision. [Section 3406 (b)(1)]
- The Central Valley Project must dedicate and manage 800,000 acre-feet of its annual yield for the primary purpose of implementing various fish, wildlife, and habitat restoration measures contained in the CVPIA. This "yield" is defined as that portion of the delivery capability of the CVP occurring during the 1928-1934 drought period after all other fishery, water quality, and flow and operational requirements in force during October 1992 have been met. [Section 3406 (b)(2)]
- Objectives of the Central Valley Joint Habitat Venture are to be supported by providing firm water supplies of suitable quality to maintain and improve wetland habitat areas on many State and Federal wildlife refuges and management areas. These areas include all units of the National Wildlife Refuge System; the Grasslands Resources Conservation District; and the Gray Lodge, Los Banos, Volta, North Grasslands, and Mendota State wildlife management areas. [Section 3406 (d)(1)]

Section 3408 of the CVPIA directs that within 3 years of enactment a plan be developed to increase CVP yield by the amount of water dedicated to fish and wildlife purposes over the next 15 years. This plan will include descriptions of options such as improved facilities and operations; water conservation; water transfers; conjunctive use; and purchases of water, land, or water rights. A major purpose of this planning is to help California meet its future water needs. [Section 3408(j)]

Chapter 3

DESCRIPTION OF SWP FACILITIES, CONTRACTOR SERVICE AREAS, AND REGIONAL ENVIRONMENTAL SETTING

The proposed Supplemental Water Purchase Program will operate in much of the service areas for the Central Valley Project and State Water Project (Figure 1). In this chapter, the physical components of the State Water Project and joint-use facilities are discussed first, followed by a general description of source areas and service areas. Chapter 4 includes environmental information related to specific impacts and mitigation. Detailed physical and biological descriptions of the environment are contained in Appendix B.

Specific areas where the proposed program may obtain and deliver water may vary widely from year to year depending on hydrologic conditions. Appropriative and riparian rights of water users along streams supplying water to the Central Valley Project and State Water Project determine water amounts available for export. However, facilities of other water agencies[1] may provide additional sources of water for transfer under the proposed Supplemental Water Purchase Program. Facilities other than those of the State Water Project are described in the environmental analysis sections in Chapter 4.

State Water Project Facilities and Contractor Service Areas

The State Water Project system consists of 22 reservoirs, 17 pumping plants, 8 hydroelectric power plants, and 550 miles of aqueducts and pipelines. The primary storage facilities are near Oroville on the Feather River, a tributary to the Sacramento River. Additional supplies are developed from surplus flows in the Delta.[2] Water from the State Water Project is transported through natural rivers and a system of canals and pipelines to the San Francisco Bay area, San Joaquin Valley, and Southern California for agricultural and municipal use. Some SWP water is delivered to the Feather River region. Construction of facilities to the San Luis Obispo and Santa Barbara county areas is nearing completion, and deliveries are expected to begin in November 1996.

The State Water Project pumps water from the Harvey O. Banks Delta Pumping Plant to the San Joaquin Valley and Southern California via the California Aqueduct

1 An example is New Bullards Bar Reservoir on the Yuba River, which belongs to Yuba County Water Agency.
2 Department of Water Resources. 1987. *California Water: Looking to the Future*. Bulletin 160-87. DWR, Sacramento.

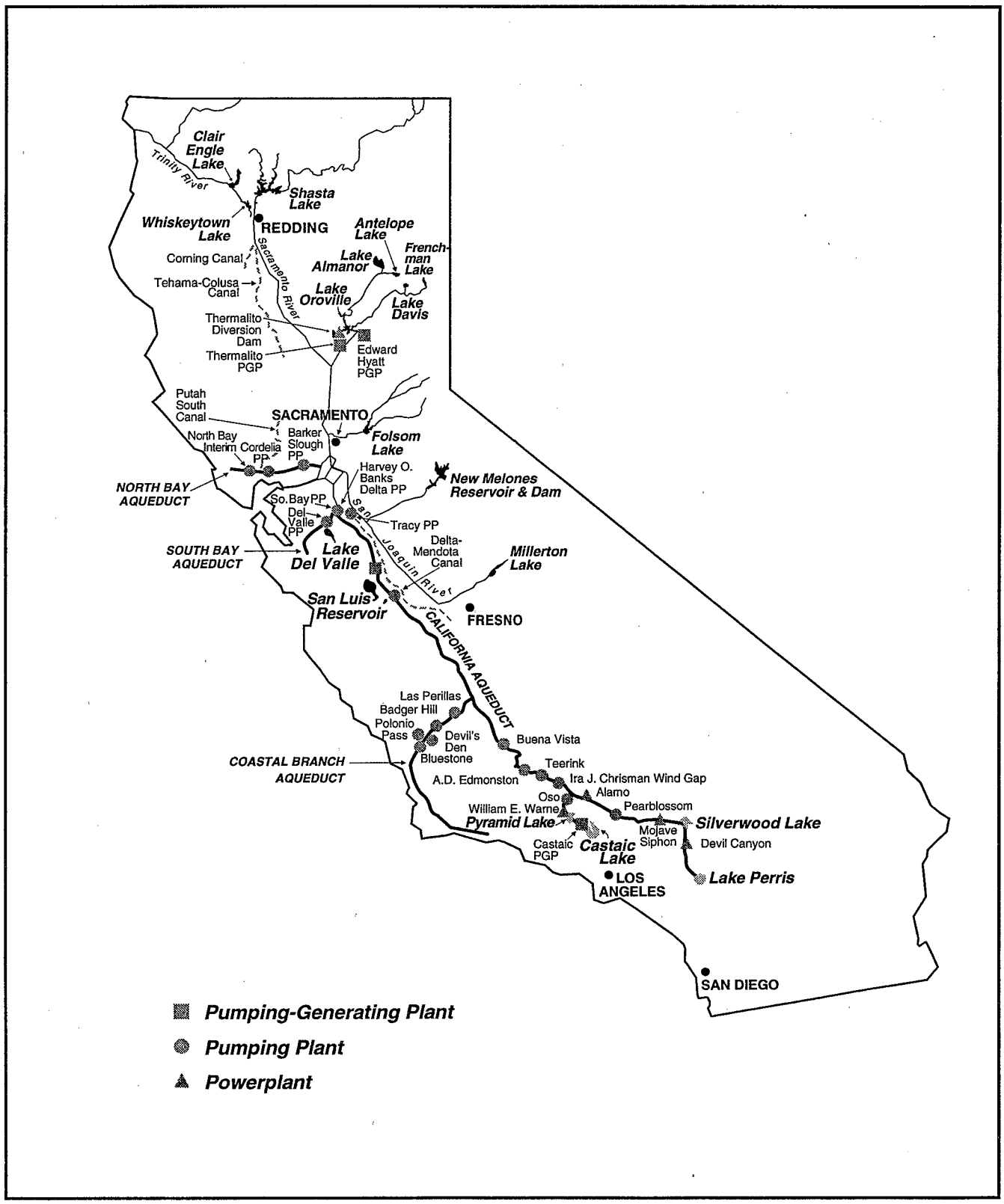

Figure 1
MAJOR FEATURES OF THE CENTRAL VALLEY PROJECT AND STATE WATER PROJECT

and to the San Francisco Bay area via the North Bay and South Bay Aqueducts. Storage facilities south of the Delta include San Luis Reservoir, Pyramid Lake, Castaic Lake, Silverwood Lake, and Lake Perris.

The State Water Project has water supply contracts with 29 public agencies whose jurisdictions encompass one-fourth of California's land area and two-thirds of its population (Figure 2). Contractual entitlements for municipal and industrial users are greater than for agricultural users, but actual deliveries were about equal during the 1980s, before the drought forced delivery reductions. During 1992, deliveries to agricultural users were only about half those to municipal and industrial users. M&I use is expected to continue to increase, as contractors request more of their entitlements. Agricultural water use is expected to remain at levels delivered before the recent drought and regulatory restrictions.

Most State Water Project water delivered in Southern California and the San Francisco Bay area is for urban use; most SWP water delivered in the San Joaquin Valley is for agriculture, largely in Kings and Kern counties and mainly in the western portions of those counties. One exception is Oak Flat Water District in western Stanislaus County. Overall (with the exception of Dudley Ridge, which relies solely on State Water Project supplies), these areas relied on the State Water Project for less than 50 percent of their irrigation water in 1992, when the estimated value of crops grown with SWP water was $397 million[3], and more than 70 percent of their irrigation water in 1993, when the estimated value of crops grown with SWP water was $595 million[4]. Cotton was the single most valuable crop in both years, accounting for 23 percent of the 1992 total and 31 percent of the 1993 total.

The State Water Project is a major water supplier for the Southern California coastal plain area, where more than half of all Californians live. Most of the water delivered is used for municipal and industrial purposes that support an economy that drove the region's total personal income over the $380 billion mark in 1993[5]. In 1975, this area relied on the State Water Project for about 15 percent of its 3.4 million acre-foot water requirement. By 1990, the south-coastal area relied on the State Water Project for about 25 percent of its water demand of more than 4 million acre-feet.[6] State Water Project supplies are expected to account for as much as 40 percent of the region's supplies in the year 2000. In the San Francisco Bay area, California's other major population center, the State Water Project supplies a smaller amount of water, but it is still crucial to the water supply.

Oroville Complex

Oroville Dam, on the Feather River, controls flooding, conserves water for release downstream, stores water for power generation, and provides recreation opportunities. Lake Oroville has a capacity of over 3.5 million acre-feet. Electrical power is generated at the Hyatt-Thermalito complex at the base of the dam. The intake to the powerplant is designed so water can be drawn from various depths in the reservoir,

3 Department of Water Resources. 1994. *Management of the State Water Project — Appendix F, San Joaquin Valley Post-Project Economic Impact, 1987-1992 Drought.* DWR, Sacramento.
4 Taken from data gathered for DWR's 1995 post-project report.
5 Center for Continuing Study of California Economy. 1994. *California Economic Growth.*
6 Department of Water Resources. 1994. *California Water Plan Update.* Bulletin 160-93. DWR, Sacramento.

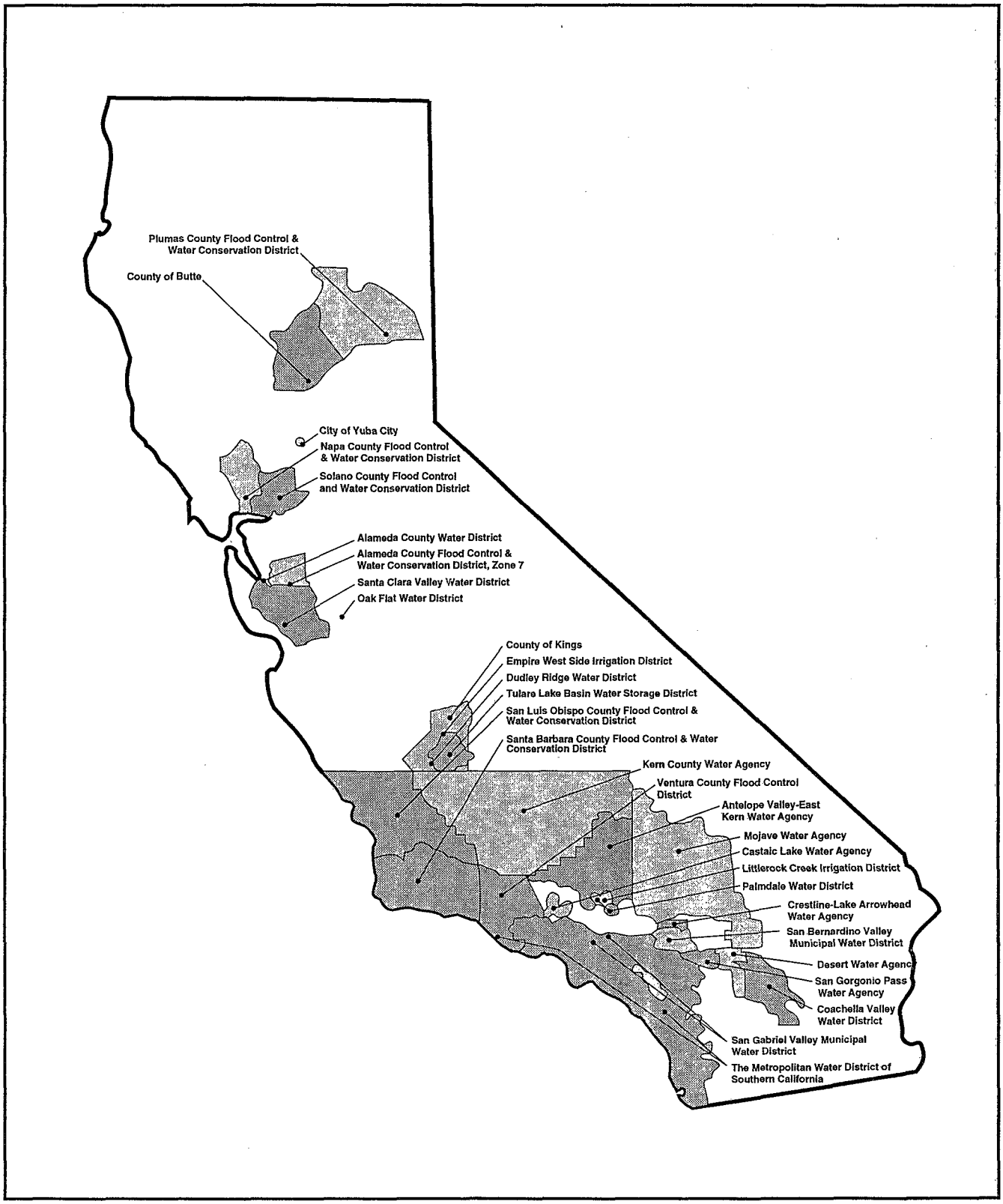

Figure 2
STATE WATER PROJECT CONTRACTORS SERVICE AREAS

thus allowing adjustments in the temperature of released water. Water released through the powerplant enters the Thermalito Diversion Pool created by Thermalito Diversion Dam about 4,000 feet downstream from Oroville Dam.

Construction of Oroville Dam on the Feather River eliminated spawning areas for salmon and steelhead upstream of the dam. To compensate for this loss, the Department of Water Resources built Feather River Fish Hatchery downstream from Oroville Dam on the northern bank of the Feather River. Cold water is supplied to the hatchery from Oroville Dam. The Feather River Fish Barrier Dam, about half a mile downstream from Thermalito Diversion Dam, diverts migrating salmon and steelhead into the Feather River Fish Hatchery for artificial spawning.

Most of the 40-mile reach of the Feather River below the Fish Barrier Dam is available for natural spawning. Minimum flows of 600 cubic feet per second are maintained in the 5-mile low-flow section between the Fish Barrier Dam and the river outlet from Thermalito Afterbay. About 80 percent of the natural spawning occurs within this reach.

The 35-mile reach of the Feather River below the Thermalito Afterbay river outlet, known as the high-flow section, receives a minimum flow of about 1,700 cfs and accommodates about 20 percent of the naturally spawning salmon.

The entire 40-mile reach below the Fish Barrier Dam is used for juvenile salmon rearing. Spawning escapement[7] generally totals about 50,000 chinook salmon, mostly fall run with some spring run; from 5,000 to 10,000 enter the hatchery. Other species using the Feather River include American shad, striped bass, steelhead rainbow trout, and many resident warmwater and coldwater species. The Department of Fish and Game propagates steelhead in the Feather River Hatchery for release to the river. Natural steelhead spawning in the Feather River is unlikely.

A portion of the fish maintenance flows is released directly to the Feather River from the Diversion Pool, but greater volumes of water are diverted to two irrigation canals, the Feather River Fish Hatchery, and Thermalito Powerplant. Four canals divert from the afterbay of the Thermalito Powerplant. Return flows from the fish hatchery and releases from Thermalito Afterbay for fish and Delta water quality return to the river below the afterbay outlet. The Feather River then flows south for 65 miles before emptying into the Sacramento River near Verona, about 21 river miles above Sacramento.

Delta Facilities

In the southern Delta near Byron, Banks Pumping Plant lifts water channeled from Clifton Court Forebay into the California Aqueduct (Figure 3). Between the forebay and the pumping plant, fish are removed from the intake channel by the John E. Skinner Fish Protective Facility. The fish facility consists of primary and secondary louver systems that divert fish into holding tanks. Salvaged fish are then transferred

7 Escapement refers to those adults that return to fresh water to spawn.

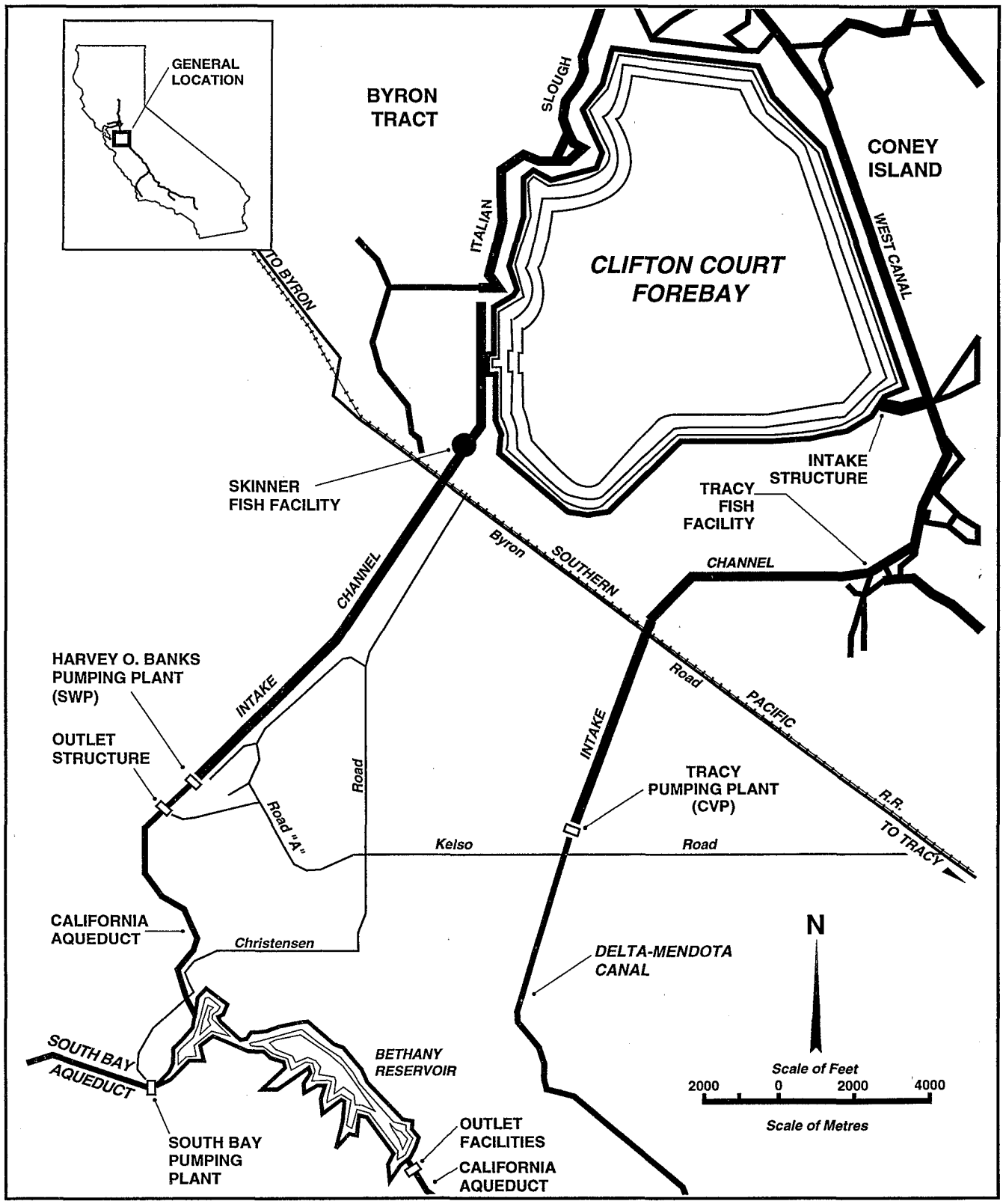

Figure 3
CVP AND SWP FACILITIES IN THE SOUTHERN DELTA

to the northern and central Delta by special tank trucks. The louver systems (behavioral fish screens) are designed to divert fish longer than 1 inch. Consequently, most eggs and small larvae enter the aqueduct, where many grow, providing the State Water Project with an important recreational fishery.

South Bay Service Area

About 5 percent of the water in Bethany Reservoir is lifted into the South Bay Aqueduct by the South Bay Pumping Plant. The South Bay Aqueduct serves Alameda and Santa Clara counties in the south and southwestern San Francisco Bay area. The aqueduct, consisting of both open canal and buried pipeline, transports water southwest through Livermore Valley, then south past Fremont, where it terminates at a 2.5-million-gallon holding tank north of San Jose. Near Livermore, water is pumped into and out of Lake Del Valle on Alameda Creek, which provides flood protection as well as off-line water storage.

San Joaquin Valley Service Area

Water continuing south in the California Aqueduct from Bethany Reservoir winds along the western edge of the San Joaquin Valley. Oak Flat Water District diverts a small amount for agricultural use, and the rest travels 65 miles to O'Neill Forebay, the starting point for the San Luis Division, which is jointly owned and operated by the State Water Project and Central Valley Project.

From O'Neill Forebay, water can be pumped into San Luis Reservoir, an off-line storage facility, by the William R. Gianelli Pumping-Generating Plant. O'Neill Dam and Forebay provide storage to permit off-peak pumping and on-peak electrical power generation.

When Delta flows cannot meet the demands of the State Water Project and Central Valley Project, water is released back into O'Neill Forebay from San Luis Reservoir to flow southward in San Luis Canal or Delta-Mendota Canal. San Luis Reservoir can store 2,038,771 acre-feet of water, of which 1,067,908 acre-feet is the State's share. O'Neill Forebay can store 56,426 acre-feet.

The San Luis Canal carries CVP and SWP water 102 miles south to Kettleman City in the southern San Joaquin Valley. Sixteen miles south of O'Neill Forebay, Dos Amigos Pumping Plant (13,200-cfs capacity) lifts water about 125 feet, permitting gravity flow past Kettleman City. The initial San Luis Canal capacity of 13,100 cfs is decreased to 8,350 cfs in the last reach. The State's share, 7,000 cfs, flows into the southern portion of the California Aqueduct at Kettleman City.

Two detention dams control stream cross-drainage and provide flood protection for the San Luis Canal. Los Banos Dam, on Los Banos Creek about 7 miles southwest of Los Banos forms Los Banos Detention Reservoir, which has a storage capacity of about 34,500 acre-feet. In addition to protecting the San Luis Canal, Los Banos Detention Reservoir provides flood protection and recreation for Los Banos and vicinity. Little Panoche Detention Dam and Reservoir are on Little Panoche Creek west of Mendota. The reservoir has a storage capacity of 5,600 acre-feet and provides flood protection and recreation.

Central Coastal Service Area

About 12 miles south of Kettleman City, the Coastal Branch Aqueduct, Phase I, splits from the California Aqueduct and transports water west 15 miles by open canal to Berrenda Mesa Water District. Two pumping plants, Las Perillas and Badger Hill, aid the transport.

Phase II of the Coastal Branch is near completion, with the first delivery of water expected in November 1996. The 100-mile buried pipeline will begin at the terminal end of the Phase I canal and extend through San Luis Obispo County to Santa Barbara County. Three pumping plants, Devil's Den, Bluestone, and Polonio, will lift water 1,500 feet over the Central Coast Range. Water will flow by gravity to the terminus on Vandenberg Air Force Base. Phase II will cost about $435 million and will supply San Luis Obispo and Santa Barbara counties with up to 47,500 acre-feet of water annually.

Southern California Service Area

Once over the Tehachapi Mountains and in Antelope Valley, the California Aqueduct divides into two branches. Both branches take water to predominantly urban customers in Southern California. The East and West Branches serve 13 water contractors.

East Branch

The East Branch carries water through Antelope Valley into Silverwood Lake in the San Bernardino Mountains. Formed by Cedar Springs Dam, Silverwood Lake can store 74,970 acre-feet.

From Silverwood Lake, water enters the San Bernardino Tunnel and drops 1,418 feet into Devil Canyon Powerplant. Water then flows in a buried pipeline to Lake Perris, the southernmost reservoir of the State Water Project, 444 miles from the Delta. Water from Lake Perris supplies Los Angeles, Orange, Riverside, and San Diego counties. The lake, about 25 miles southeast of Riverside, has a capacity of 131,452 acre-feet.

The East Branch serves Antelope Valley-East Kern Water Agency, Palmdale Water District, Littlerock Creek Irrigation District, and Mojave Water Agency in the Antelope and Mojave basins. The East Branch also conveys water to the Crestline-Lake Arrowhead Water Agency in the San Bernardino Mountains, and to Metropolitan Water District of Southern California, San Gabriel Valley Municipal Water District, San Bernardino Valley Municipal Water District, and indirectly to Desert Water Agency, and Coachella Valley Water District downstream of the Devil Canyon Powerplant Afterbay. Desert Water Agency and Coachella Valley Water District now trade SWP water to Metropolitan Water District in exchange for Colorado River water, because they do not have facilities to convey SWP water from the East Branch to their service areas.

Preliminary design of an extension of the East Branch has recently been completed, which will enable the Department of Water Resources to meet its obligation to provide water to San Gorgonio Pass Water Agency and at the same time provide additional delivery flexibility for San Bernardino Valley Municipal Water District. Construction of the extension is expected to be completed in 1999.

West Branch

Water in the West Branch flows through William E. Warne Powerplant into Pyramid Lake, in northwestern Los Angeles County. The lake stores 171,196 acre-feet, supplies water for Metropolitan Water District of Southern California, Castaic Lake Water Agency, Ventura County Flood Control and Water Conservation District, and other southern coastal cities, and regulates storage for Castaic Powerplant downstream.

Releases from Pyramid Lake flow through the Angeles Tunnel and Castaic Powerplant, and into Castaic Lake, the terminus of the West Branch. Energy produced from the 1,250-megawatt Castaic Powerplant is used by the city of Los Angeles and the State Water Project. Castaic Lake stores 323,702 acre-feet and is a major water source for Los Angeles, Ventura, and Orange counties. The West Branch serves Castaic Lake Water Agency, Ventura County Flood Control District, and Metropolitan Water District of Southern California. Ventura County Flood Control and Water Conservation District has not yet taken delivery of water from the State Water Project.

In Ventura and Los Angeles counties, some State Water Project supplies are released into natural stream channels from the West Branch. Piru Creek, a tributary to the Santa Clara River, serves as a conveyance to Ventura County users.

Central Valley

The Central Valley includes two major river basins, the Sacramento River to the north and the San Joaquin River to the south, plus the Tulare Lake basin (Figure 4). The combined watersheds extend nearly 500 miles northwest to southeast and average about 120 miles wide. The watersheds contain about 38 million acres — more than a third of California. The basin is surrounded by mountains except for a narrow gap on the western edge, at Carquinez Strait. The Sacramento River and its tributaries flow southward, draining the northern part of the basin. The San Joaquin River and its tributaries flow northward, draining the central and southern portion. The two river systems join at the westernmost part of the Delta, flow through Suisun Bay and Carquinez Strait into San Francisco Bay, and out the Golden Gate to the Pacific Ocean.

The valley floor, a gently sloping, nearly unbroken alluvial plain, occupies about one-third of the basin. The other two-thirds is mountainous. The valley floor is about 400 miles long and averages about 45 miles wide. The Cascade Range on the north and Sierra Nevada on the east rise to an elevation of about 14,000 feet. The Coast Ranges on the west are generally less than 4,000 feet but rise to as high as 8,000 feet at the northern end.

The primary use of water in the Central Valley is crop irrigation, but it is also used for urban communities, industries, overdraft correction, and other uses. Surface water supplies have been developed by local irrigation districts, municipal utility districts, county agencies, private companies or corporations, and State and Federal agencies.

With certain exceptions, water quality throughout the Central Valley is adequate. Quality problems are almost absent in the mountainous areas. On the valley floor, streamflow and water quality during the late summer are dependent on operation of upstream reservoirs.

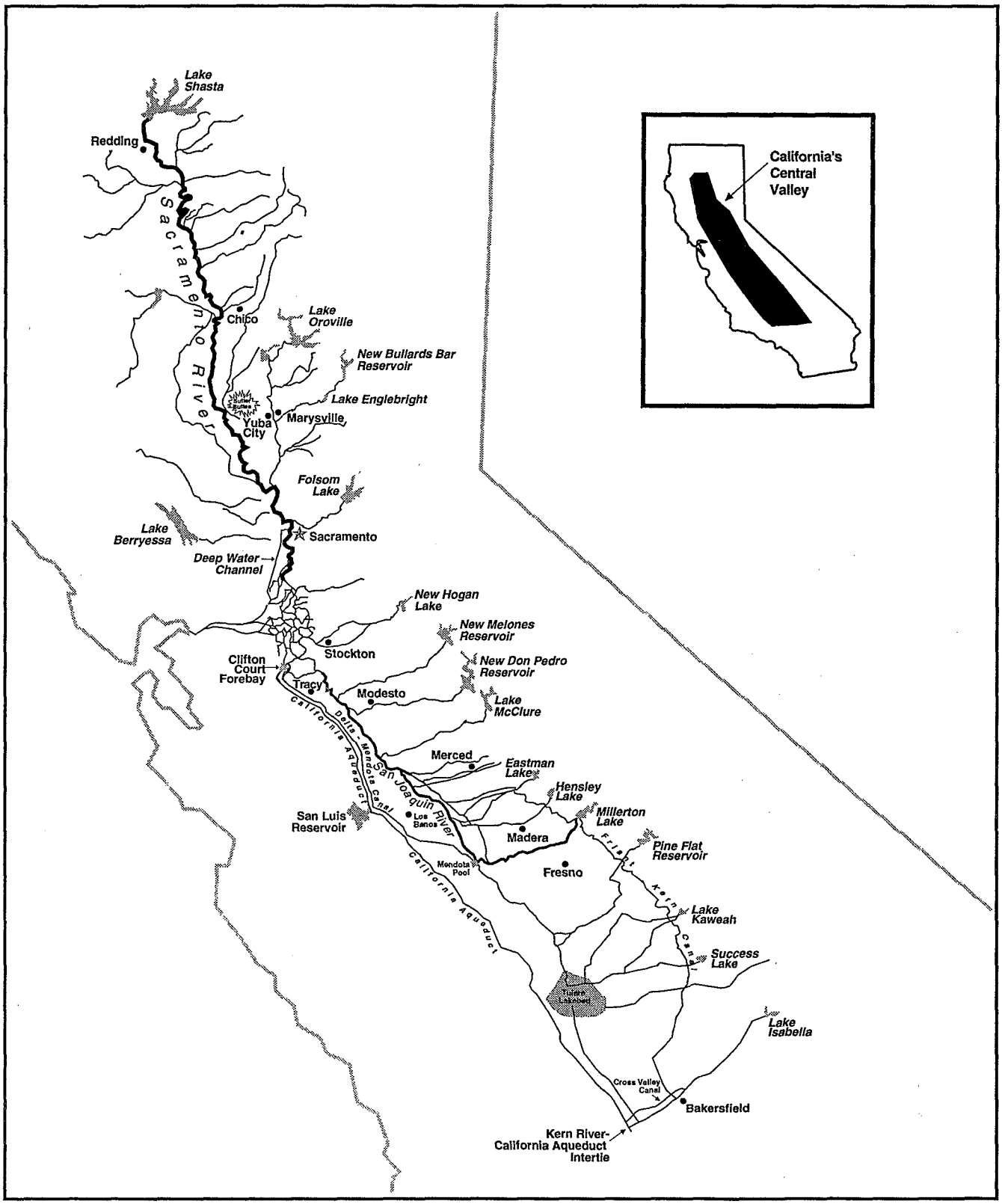

Figure 4
CALIFORNIA'S CENTRAL VALLEY

Water for the Central Valley is supplied mainly by runoff from the Sierra Nevada and its foothills, with minor amounts supplied by streams entering the west side from the Coast Ranges. Rainfall on the valley floor also contributes to the supply. Precipitation varies widely from year to year and a significant portion is snow in the mountains, so the season of runoff often extends into late spring and summer as the snow melts. About 75 percent of the annual precipitation falls between the last of October and the first of April, but snow storage in the high Sierra delays runoff from that area until April, May, and June, when half the annual runoff normally occurs.

The average annual natural Central Valley Basin runoff into the Delta for water years 1922 through 1992 was about 28 million acre-feet; for the 7-year critically dry period of 1928 to 1934, runoff averaged about 17 million acre-feet annually. Annual rainfall averages more than 15 inches in the Sacramento Valley, and rain and snowfall in surrounding mountains average more than 50 inches annually over large areas.[8] Averages are lower in the San Joaquin Valley and surrounding mountains.

All major streams in the Central Valley have flood control or water storage works, which alter the natural flow patterns. These facilities store water for the dry season and protect against the devastating winter floods that were common before water development. They also produce hydroelectric power, enhance recreation opportunities, and serve other needs.

A complex aquifer system underlies the Central Valley. Depth to water ranges from near ground surface to more than 900 feet. Usable storage capacity at a depth of 200 feet has been estimated at 80 million to 93 million acre-feet in the San Joaquin Basin and 22 million to 33 million acre-feet in the Sacramento Basin.[9, 10] Low yield in some areas is a limiting factor. Groundwater temperatures average about 65°F and range from about 45 to 105°F. The dissolved solids content of groundwater averages about 500 parts per million and ranges from 64 to 10,700 ppm. Predominant constituents in the groundwater vary with location in the aquifer, but calcium, magnesium, sodium, bicarbonates, sulfate, and chloride all occur in significant quantities.

Sacramento-San Joaquin Delta

The Delta, a 738,000-acre region of low-lying land and waterways, is the hub of the Central Valley Project, State Water Project, and numerous local water supply projects (Figure 5). Water is diverted from Delta channels to meet the needs of about two-thirds of California's population and to irrigate 4.5 million acres.[11] Delta agricultural water users divert directly from the channels, using more than 1,800 unscreened pumps and siphons, which vary from 4 to 30 inches in diameter and have flow rates of 4 to about

8 U.S. Bureau of Reclamation and Department of Water Resources. 1985. *Joint Environmental Impact Statement and Environmental Impact Report; Proposed Agreement Between the United States of America and the Department of Water Resources of the State of California for Coordinated Operation of the Central Valley Project and the State Water Project.* DWR, Sacramento.

9 Department of Water Resources. 1975. *California's Ground Water.* Bulletin 118. DWR, Sacramento.

10 U.S. Bureau of Reclamation. 1970. *Central Valley Water Resource Study.* Federal Water Pollution Control Administration and USBR, San Francisco and Sacramento.

11 Department of Water Resources. 1988. *North Delta Water Management Program.* DWR Central District, Sacramento.

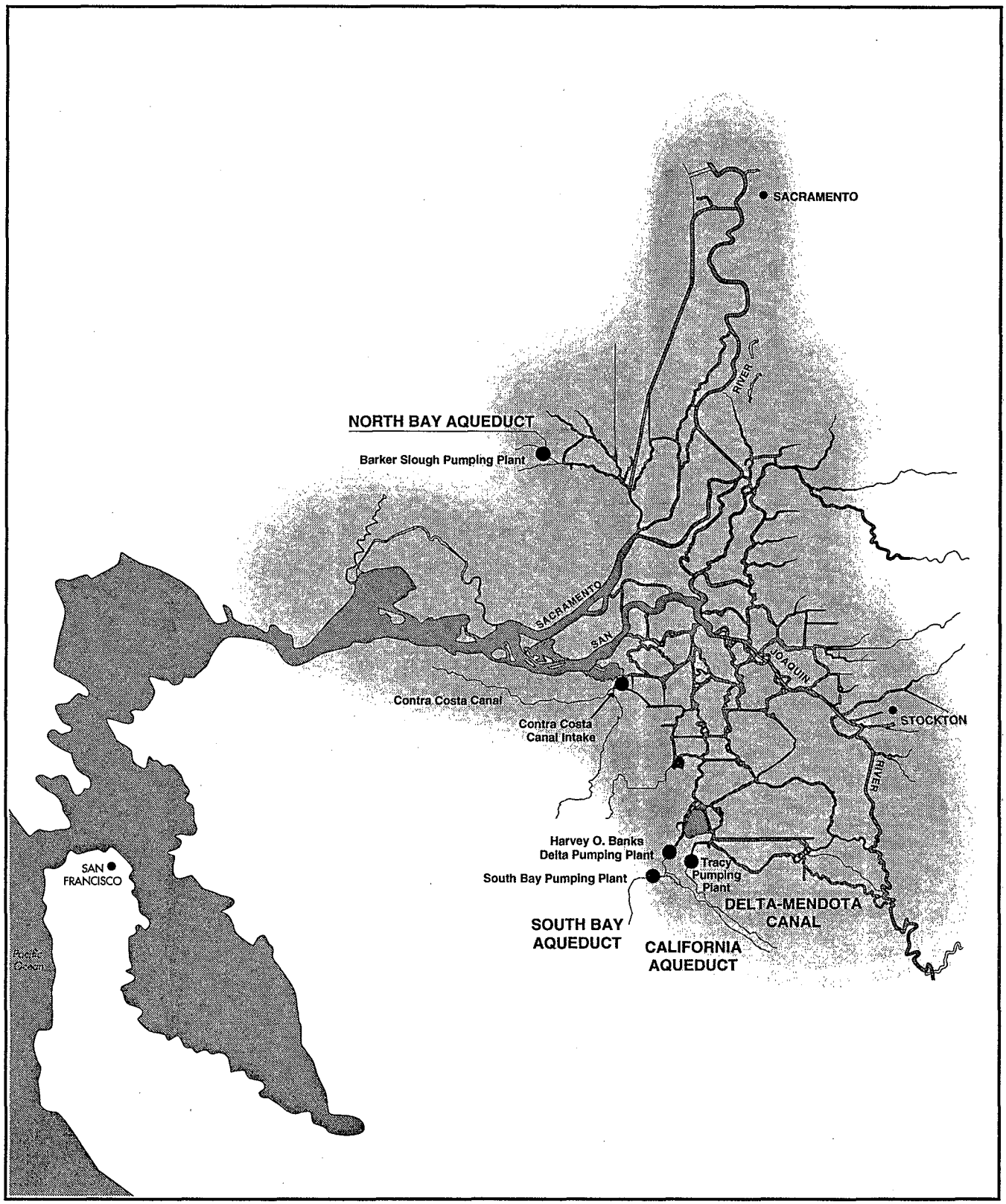

Figure 5
SACRAMENTO-SAN JOAQUIN DELTA

200 cubic feet per second. Diversions vary between 2,500 and 5,000 cfs during April through August, with maximum rates in July.[12]

The Sacramento and San Joaquin rivers unite at the western end of the Delta at Suisun Bay. The Sacramento River contributes roughly 85 percent of the Delta inflow in most years; the San Joaquin River contributes about 10 to 15 percent. The minor flows of the Mokelumne, Cosumnes, and Calaveras rivers, which flow through the Delta from the east, contribute the rest. From Suisun Bay, water flows through Carquinez Strait into San Pablo Bay (the northern half of San Francisco Bay) and then through the Golden Gate to the Pacific Ocean.

Tidal influence is important throughout the Delta. During summer, when mountain runoff historically dwindled, ocean water intruded upstream as far as Sacramento and Stockton. During winter and spring, fresh water from heavy rains pushed the salt water back, sometimes past the mouth of San Francisco Bay.

With the addition of Shasta, Folsom, and Oroville dams, salt water intrusion during summer has been controlled by reservoir releases. Typically, peaks in winter and spring flows have been dampened, and summer and fall flows have been increased. In very wet years such as 1969, 1982, 1983, 1986, and 1995, when large amounts of water are released from reservoirs for flood control along with uncontrolled flows, rainfall, and runoff, the upper bays become fresh, and even the upper several feet of water at the Golden Gate is fresh water.

On the average, about 27.8 million acre-feet of water reaches the Delta annually, but actual inflow varies widely from year to year and within the year.[13] In 1977, a year of extraordinary drought, Delta inflow totaled only 5.9 million acre-feet. Inflow for 1983, an exceptionally wet year, was about 62 million acre-feet. On a seasonal basis, average natural flow to the Delta varies by a factor of more than 10 between the highest month in winter or spring and the lowest month in fall.

During normal water years, water reaching the Delta would generally be distributed as follows:

6 percent	Local use
18 percent	Export by the Central Valley Project and State Water Project
21 percent	Salinity control
55 percent	Delta outflow in excess of minimum requirements.[14]

Hydraulics of the estuary system are complex. The influence of tide is combined with freshwater outflow, resulting in flow patterns that vary daily. Inflow varies seasonally and is affected by upstream diversions. Hydraulics are further complicated by a multitude of agricultural, industrial, and municipal diversions for use in the Delta itself and by exports of the Central Valley Project and State Water Project. Delta outflow is affected by tides, freshwater inflow, internal use, and export pumping. Because of the large tidal flows (about 300,000 cubic feet per second), outflow (3-10,000 cfs) must be calculated rather than measured. Calculated outflows are reasonably

12 Department of Water Resources. 1982. *Screening Agricultural Diversions in the Sacramento-San Joaquin Delta.* Internal report by R.L. Brown.

13 Department of Water Resources. 1994. *California Water Plan Update.* Volume 1, Bulletin 160-93. DWR, Sacramento.

14 The excess outflow would occur almost entirely during the season of high inflow.

accurate on time scales longer than a few weeks but are not at all accurate for shorter time scales.

The Delta has a Mediterranean climate with warm, rainless summers and cool, damp winters. Annual rainfall varies from about 18 inches in the eastern and central parts to about 12 inches in the southern part. Ocean winds enter the Delta through Carquinez Strait and at times are very strong in the western Delta.

Before development began in the mid-19th century, the Delta was mainly tule marsh and grassland, with some high spots rising to a maximum of about 10 to 15 feet above mean sea level. The low dikes of early farmers became a system of levees that now protect about 520,000 acres on 60 major islands and tracts. There are now about 1,100 miles of levees, some standing 25 feet high and reaching 200 feet across at the base. Behind the levees, peat soils have subsided over the years due to oxidation, shrinkage, and soil loss by wind erosion. As a result, some of the island surfaces now lie more than 20 feet below mean sea level and as much as 30 feet below high tide water levels in surrounding channels. All the major tracts and islands have been flooded at least once since their original reclamation, and a few have been allowed to remain flooded. Land in the areas of deep peat soil, where subsidence has been greatest, is expensive both to protect from inundation and to reclaim from inundation once flooded.

More than 100 fish species can be found in the estuary. Important game fish include American shad, chinook salmon, steelhead, and striped bass. Although all these anadromous fish spend most of their adult lives in the lower bays or in the Pacific Ocean, the Delta is a major nursery area for most of them. Other fish in the estuary include catfish, black bass, crappie, bluegill, and several threatened, endangered, or candidate species. More detail on fish and wildlife resources in the Delta is contained in Appendix B.

The Delta is an important agricultural area. Historically, the area was noted for its truck crops, such as asparagus, potatoes, and celery, but since the 1920s, there has been a shift toward lower valued field crops. Corn, grain, hay, and pasture currently account for more than 75 percent of the region's total production. The change has been attributed mainly to market conditions, although technological change and changes in growing conditions have also played a role. Delta farming produces an average gross income of about $375 million.[15]

The Delta is generally bordered by the cities of Sacramento, Stockton, Tracy, and Pittsburg. The smaller cities of Antioch, Brentwood, and Isleton plus about 14 unincorporated towns and villages also lie within the Delta area. The population of the Delta is about 200,000, most in upland areas on the eastern and western fringes. Most Delta islands are sparsely populated but some, including Byron Tract and Bethel Island, have large urban communities.

15 Department of Water Resources. 1990. *Draft Environmental Impact Report/Environmental Impact Statement, North Delta Program.* DWR, Sacramento.

San Francisco Bay

Runoff from the northern and southern Central Valley converges in the Delta before discharging to the Pacific Ocean through San Francisco Bay (Figure 6). Fish migrating to Central Valley streams to spawn or returning to the ocean travel through the bay.

Nine counties surround San Francisco Bay: Marin, San Francisco, San Mateo, Santa Clara, Alameda, Contra Costa, Solano, Napa, and Sonoma. In 1987, the Bay Area became the fourth largest metropolitan area in the United States. The total population was about 5.8 million in 1988 and is projected to reach 6.7 million by 2005.

Water requirements in the Bay Area are met by local surface and groundwater and imported surface water. The conveyance systems that bring the area most of its water are Hetch Hetchy, South Bay, North Bay, Mokelumne, Petaluma, and Santa Rosa-Sonoma aqueducts; Contra Costa and Putah South canals; Cache Slough Conduit; and the San Felipe Project. More than 60 percent of the water is imported from the Delta or streams tributary to the Delta.

The San Francisco Bay area contains some 3,650,000 acres and includes the Russian River Basin and several smaller basins tributary to the Pacific Ocean, as well as the San Francisco Bay system composed of Suisun, San Pablo, and San Francisco bays. San Francisco Bay is the largest bay on the California coast, with a water surface area of about 420 square miles at mean high water, 274 miles of shoreline (not including islands), and about 130 square miles of adjacent tidal flats and marshes.

The San Francisco Bay complex supports a wide variety of fish — more than 100 species. Habitat types in the bay include open water, tidal mudflats, and marshland. These habitats are used by various anadromous fish, including chinook salmon, striped bass, sturgeon, American shad, and steelhead. Marine fish, found mainly in the lower bays, include flatfish, sharks, and surf perch. Other popular sport fish include jacksmelt and topsmelt. Shellfish include mussels, oysters, clams, crabs, and shrimp. Other fish in the estuary include catfish, black bass, crappie, bluegill, and several threatened, endangered, or candidate species. Appendix B contains more detail on fish and wildlife resources.

Suisun Marsh, one of the few major marshes remaining in California, is at the northern edge of Suisun Bay, just west of the confluence of the Sacramento and San Joaquin rivers. The area contains 58,600 acres of marsh, managed wetlands, and adjacent grasslands, plus 29,500 acres of bays and waterways. Most of the managed wetlands are enclosed within levee systems, and about 70 percent are privately owned by more than 150 duck clubs. The Department of Fish and Game owns and manages 14,000 acres. Another 1,400 acres on the channel islands is owned by the Federal Government.

Suisun Marsh is protected by several standards, agreements, and facilities. Among them is Water Right Decision 1485, which requires the Central Valley Project and State Water Project to mitigate their impacts on the marsh by meeting specific standards for the Sacramento River at Collinsville and seven other stations in the marsh. As allowed by Decision 1485, facilities have been constructed to provide water from internal channels to certain wetland areas. In addition, in 1987 the Department of Water Resources, U.S. Bureau of Reclamation, Department of Fish and Game, and

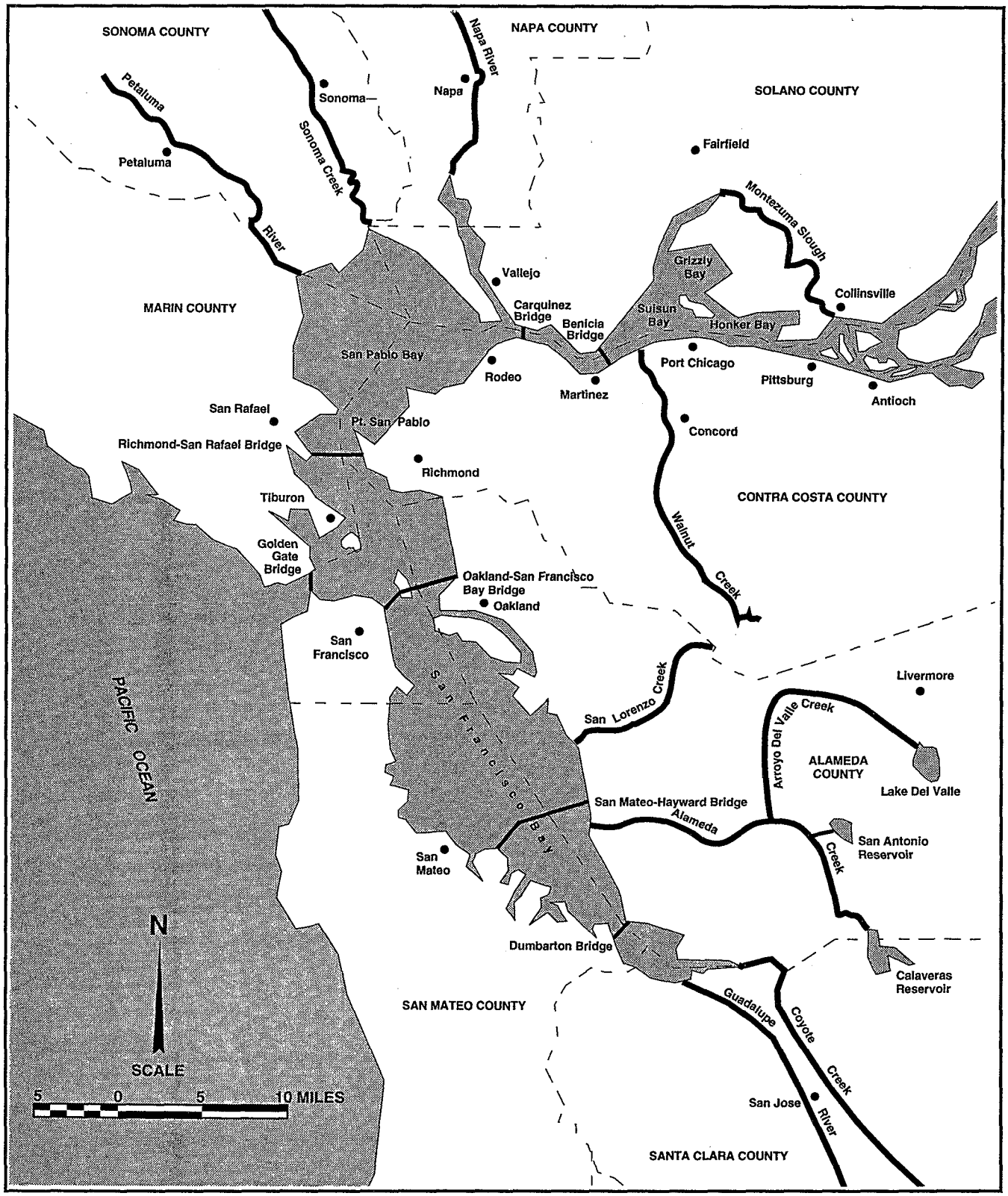

Figure 6
SAN FRANCISCO BAY ESTUARY

Suisun Resource Conservation District signed a Suisun Marsh Preservation Agreement to assure that a dependable water supply will be maintained in the marsh to produce duck food and preserve other habitat.

The surface hydrology of San Francisco Bay can be divided into two distinct patterns. The northern bay, including San Pablo and Suisun bays, receives freshwater outflow from the Delta and functions as part of the Bay/Delta estuary. The southern bay receives scant runoff and functions like a lagoon. Circulation in and flushing of the bay depend on tides and outflow. Circulation is primarily a tidal process, while flushing is believed to depend on tidal action supplemented by periodic outflow surges following winter storms.

Central Coast

The Central Coast service area, consisting of San Luis Obispo and Santa Barbara counties, encompasses about 3.9 million acres. Service to the area would involve completion of Phase II of the Coastal Branch of the California Aqueduct (Figure 7). The Phase II facilities will transport 47,816 acre-feet of water to the area, although full State Water Project entitlement for these areas is about 50,000 acre-feet per year.

In Kern County, Phase II of the Coastal Branch would be in the northwestern portion and eastern foothill regions of the Coast Ranges. The area is relatively barren, with few streams or other drainages. Elevation of the valley floor is about 500 feet, and hills near the project area range from 1,000 to 2,500 feet at Bluestone Ridge.

San Luis Obispo County consists of three broad physiographic regions: a coastal plain, coastal mountains and valleys, and interior mountains and valleys. Elevations range from sea level along the coastal plain to 5,106 feet at the Caliente Mountain summit, in the southeast corner of the county. The seven cities in the county are Arroyo Grande, Atascadero, Grover City, Morro Bay, Paso Robles, Pismo Beach, and San Luis Obispo.

Santa Barbara County has the same three broad physiographic regions. The topography is dominated by the Sierra Madre, San Rafael, and Santa Ynez mountain ranges. Elevations within the county vary from sea level to 6,828 feet at the summit of Big Pine Mountain. The six cities of Santa Barbara County are Santa Barbara, Santa Maria, Lompoc, Carpinteria, Solvang, and Guadalupe. Unincorporated communities include Goleta, Buellton, Mission Hills, Montecito, Orcutt, Santa Ynez, and Vandenberg Village. Vandenberg Air Force Base dominates the western coastal area of the county.

The climate is Mediterranean, with mild, moist winters and warm, dry summers. Mountain ranges intercept much of the rain, producing drier climates and even deserts in eastern San Luis Obispo and western Kern counties. The wettest areas are in the Santa Lucia and Sierra Madre ranges, with an average annual rainfall of 40 inches. Antelope Valley, in Kern County, is one of the driest areas, with an average annual rainfall of only 7 inches. Average rainfall of the coastal plains of San Luis Obispo and Santa Barbara counties is 14 to 20 inches. Precipitation varies considerably from year to year, with most falling during November through April. Fog is frequent along a 2- to 15-mile-wide coastal strip.

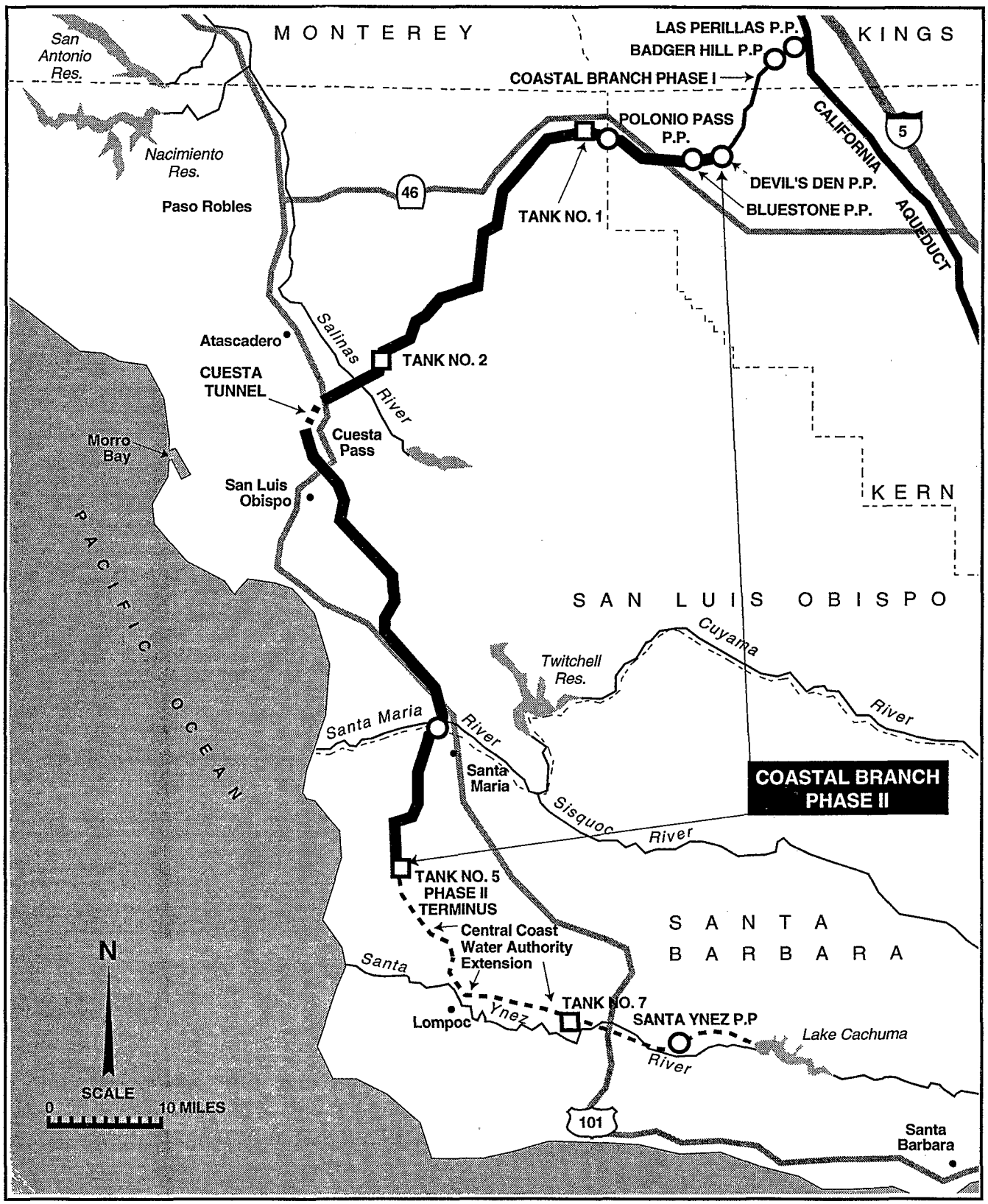

Figure 7
CENTRAL COAST SERVICE AREA

The Santa Ynez, Santa Maria, and Salinas rivers constitute the major drainages of the Central Coastal service area. The Salinas River is the largest single watershed in the Central Coast area and flows northward into Monterey County and discharges into Monterey Bay. Dams and canals have been constructed on these rivers to conserve runoff. A limited amount of State Water Project water has been imported to the South Coast of Santa Barbara through a series of transfers from the Department of Water Resources, the Metropolitan Water District of Southern California, and other local agencies.

Groundwater is the main source of water supply in the Central Coast area. Overuse of groundwater resources has led to overdrafting and water quality problems in some locations, such as the Santa Maria Valley and southern coastal Santa Barbara County.

The economy of the Central Coast service area depends on agriculture and related activities. In the coastal lowlands, there is considerable high-value fruit and vegetable farming. In the drier lowlands inland, livestock and dry-farmed grains are produced. Manufacturing is limited, but heavy water-using industries are present: petroleum production; food processing; and stone, clay, and glass products. Some mining and military installations also contribute to the region's economy. Recreation and retirement activities are increasing.

The agricultural preserve program, under the Williamson Act, has helped limit urbanization of agricultural land in Santa Barbara County. Land committed to public use includes Vandenberg Air Force Base, Los Padres National Forest, and other U.S. Forest Service land.

Southern California

The Southern California service area of the State Water Project includes Ventura, Los Angeles, and Orange counties and parts of San Diego, Riverside, Imperial, San Bernardino, and Kern counties (Figure 8).

Since the 1940s, Southern California has changed from a largely rural lifestyle with an agricultural economy to a highly urban-industrial society. In 1986, the estimated population was over 15 million. Los Angeles County, the most populous county in California, has had the largest increase.

The East Branch of the California Aqueduct extends through an area that is characteristically hot and dry in the summer, with temperatures exceeding 100°F. Winters are fairly cold, and freezing is frequent. Average length of the growing season is about 260 days. Precipitation in the Antelope and Mojave basins occurs primarily in the winter and spring. Average annual precipitation is 5 to 8 inches on the valley floor and 12 to 16 inches in the foothills bordering the basins.

The high Antelope Valley and Mojave Desert form a broad basin, with remnants of eroded mountains and ridges. The San Gabriel Mountains, the dominant mountain range, extend from the Quail Lake area on the west to the Cajon area on the east. Average elevation exceeds 4,000 feet, with many peaks well over 8,000 feet.

The southern boundary of the Antelope and Mojave basins includes a portion of the San Andreas fault rift zone, which consists of a series of long, narrow valleys separated from Antelope Valley by narrow ridges. Most prominent of these fault valleys and ridges is Leona Valley, which contains Elizabeth Lake, Lake Hughes, and Portal Ridge, west of Palmdale. From Portal Ridge, the southern boundary follows the northern slope of the San Gabriel Mountains to Cedar Springs Dam. An extensive alluvial fan that spreads into the valley from this boundary is characterized by a series of mesas, low hills, and playa lakes[16]. The largest of the playas, Rosamond, Rogers, and Buckhorn lakes, are dry lake beds that are the terminuses of drainages and washes formed by intermittent streams draining the east slope of the Tehachapis and the north slope of the San Gabriel Mountains.

Cedar Springs Dam, on the West Fork Mojave River, is on the southeastern boundary of the area within the Antelope and Mojave basins. Below Cedar Springs Dam, the Mojave River joins Deep Creek and other tributaries from the San Bernardino Mountains and follows a course northward into the Mojave sink, where it terminates in several playas, including the dry Soda, Silver, and East Cronese lakes.

Mojave Valley, northeast of Cedar Springs Dam, consists of a large alluvial plain interspersed with numerous mountains, mesas, valleys, playas, and the lowlands bordering the Mojave River.

16 A playa lake is a body of water covering a hard, clayey bottom.

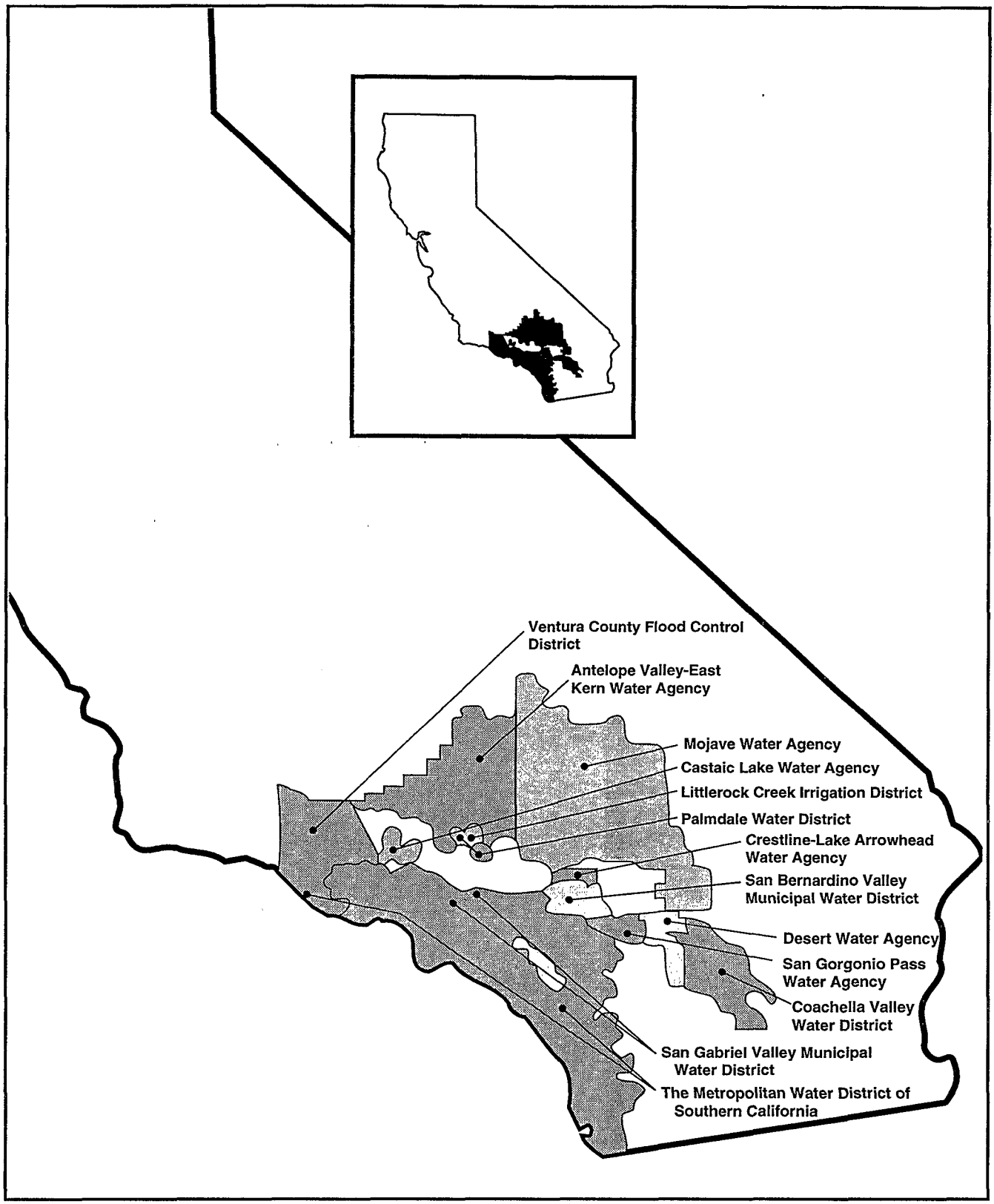

Figure 8
SOUTHERN CALIFORNIA SERVICE AREA

Chapter 4

POTENTIAL ENVIRONMENTAL IMPACTS AND PROGRAMWIDE MITIGATION MEASURES

An Environmental Checklist (Exhibit A) from the CEQA Guidelines[1] was used to aid and focus this environmental assessment of the proposed Supplemental Water Purchase Program. No adverse effects would be expected to the air, noise levels, light and glare, rate in use of natural resources, risk of upset, distribution of the human population, housing, transportation, public services, utilities, human health, esthetics, or cultural resources as these items are generally impacted as a result of a construction-type project, and no new construction is expected under this program. This chapter presents an analysis of the potential environmental effects and programwide mitigation measures for the proposed project in those areas of the checklist (Exhibit A) where a "yes" or "maybe" was checked: earth, water, plant life, animal life, land use, public services, energy, and recreation.

To implement the Supplemental Water Purchase Program, the Department of Water Resources will assign a program manager, who will be responsible for program administration. This will involve review of proposed and ongoing water transfers to ensure compliance with all legal requirements, including CEQA and other environmental laws and regulations. Review of proposed water transfers will first use the checklist in Exhibit A to identify any possible significant adverse environmental impacts associated with various program activities. Environmental reviews will determine if this these impacts were addressed in document. The program will be adjusted, appropriate mitigation will be prescribed, or additional documentation will be prepared to the extent that is feasible and legally required in connection with each specific water transfer activity.

Because of the myriad combinations of possible water transfers — in various amounts, from a wide variety of sources, and with a wide variety of delivery options — as well as unknown hydrologic conditions in future years, this analysis is based primarily on experience from previous Drought Water Banks and other water transfer activities. Also, because the State Water Project operates under the water quality standards contained in the 1995 Water Quality Control Plan for the Bay and Delta[2], analyses represent expected hydrologic and environmental conditions in the Delta during the period (July-October) when transfers under the proposed program are likely to take place.

1 Governor's Office of Planning and Research. 1992. *CEQA — California Environmental Quality Act, Statutes and Guidelines.* Office of Permit Assistance, Sacramento.

2 State Water Resources Control Board. 1995. *Water Quality Control Plan for the San Francisco Bay / Sacramento-San Joaquin Delta Estuary.*

Exhibit A — Environmental Checklist
SWP Supplemental Water Purchase Program

			Yes	Maybe	No
I	**EARTH.** Will the proposal result in:				
	a	Unstable earth conditions or changes in geologic substructures?			X
	b	Disruptions, displacements, compaction, or overcovering of the soil?		X	
	c	Change in topography or ground surface relief features?			X
	d	Destruction, covering, or modification of any unique geologic or physical features?			X
	e	Any increase in wind or water erosion of soils, either on or off the site?			X
	f	Changes in deposition or erosion of beach sands or changes in siltation, deposition, or erosion which may modify the channel of a stream or the bed of the ocean or any bay, inlet, or lake?			X
	g	Exposure of people or property to geologic hazards such as earthquakes, landslides, mudslides, ground failure?			X
II	**AIR.** Will the proposal result in:		Yes	Maybe	No
	a	Substantial air emissions or deterioration of ambient air quality?			X
	b	Creation of objectionable odors?			X
	c	Alteration of air movement, moisture, or temperature, or any change in local or regional climate?			X
III	**WATER.** Will the proposal result in:		Yes	Maybe	No
	a	Changes in currents or the course or direction of water movement in marine or fresh waters?			X
	b	Changes in absorption rates, drainage patterns, or the rate and amount of surface runoff?	X		
	c	Alterations to the course or flow of flood waters?			X
	d	Changes in the amount of surface water in any water body?	X		
	e	Discharge into surface waters or any alteration of surface water quality including, but not limited to, temperature, dissolved oxygen, or turbidity?		X	
	f	Alteration of the direction or rate of flow of groundwaters?		X	
	g	Change in the quantity of groundwaters either through direct additions or withdrawals or through interception of an aquifer by cuts or excavations?	X		
	h	Substantial reduction in the amount of water otherwise available for public water supplies?			X
	i	Exposure of people or property to water-related hazards such as flooding or tidal waves?			X
IV	**PLANT LIFE.** Will the proposal result in:		Yes	Maybe	No
	a	Change in the diversity or number of any plant species, including trees, shrubs, grass, crops, and aquatic plants?		X	
	b	Reduction in numbers of any unique, rare, or endangered plant species?			X
	c	Introduction of new plant species into an area or in a barrier to the normal replenishment of existing species?			X
	d	Reduction in acreage of any agricultural crop?		X	
V	**ANIMAL LIFE.** Will the proposal result in:		Yes	Maybe	No
	a	Change in the diversity or number of any animal species, including birds, land animals, reptiles, fish and shellfish, benthic organisms, and insects?		X	
	b	Reduction in numbers of any unique, rare, or endangered animal species?			X
	c	Introduction of new animal species into an area or in a barrier to the migration or normal movement of animals?			X
	d	Deterioration of existing fish or wildlife habitat?		X	
VI	**NOISE.** Will the proposal result in:		Yes	Maybe	No
	a	Increases in existing noise levels?			X
	b	Exposure of people to severe noise levels?			X
VII	**LIGHT AND GLARE.** Will the proposal result in:		Yes	Maybe	No
	a	Produce new light or glare?			X
VIII	**LAND USE.** Will the proposal result in:		Yes	Maybe	No
	a	Substantial alteration of the present or planned land use of an area?		X	
IX	**NATURAL RESOURCES.** Will the proposal result in:		Yes	Maybe	No
	a	Increased rate of use of any natural resources?			X
X	**RISK OF UPSET.** Will the proposal result in:		Yes	Maybe	No
	a	Risk of an explosion or release of hazardous substances (including, but not limited to, oil, pesticides, chemicals, or radiation) in the event of an accident or upset conditions?			X
	b	Possible interference with an emergency response plan or an emergency evacuation plan?			X
XI	POPULATION. Will the proposal result in:		Yes	Maybe	No
	a	Alteration of the location, distribution, density, or growth rate of the human population of an area?			X

Exhibit A — Environmental Checklist
SWP Supplemental Water Purchase Program

		Yes	Maybe	No
XII	HOUSING. Will the proposal result in:			
a	Adverse effects on existing housing or a demand for additional housing?			x
XIII	TRANSPORTATION AND CIRCULATION. Will the proposal result in:	Yes	Maybe	No
a	Generation of substantial additional vehicular movement?			x
b	Adverse effects on existing parking facilities or a demand for new parking facilities?			x
c	Substantial adverse impacts on existing transportation systems?			x
d	Alterations to patterns of circulation or movement of people or goods?			x
e	Alterations to waterborne, rail, or air traffic?			x
f	Increased traffic hazards to motor vehicles, bicyclists, or pedestrians?			x
XIV.	PUBLIC SERVICES. Will the proposal result in:	Yes	Maybe	No
a	Adverse effects on or a need for new or altered fire protection?			x
b	Adverse effects on or a need for new or altered police protection?			x
c	Adverse effects on or a need for new or altered schools?			x
d	Adverse effects on or a need for new or altered parks or other recreational facilities?		x	
e	Adverse effects on maintenance of or a need for new or altered public facilities, including roads?			x
f	Adverse effects on or a need for new or altered governmental services of any other type?			x
XV	ENERGY. Will the proposal result in:	Yes	Maybe	No
a	Use of substantial amounts of fuel or energy?		x	
b	Substantial increase in demand on existing energy sources or a need to develop new energy sources?		x	
XVI	UTILITIES AND SERVICE SYSTEMS. Will the proposal result in a need for:	Yes	Maybe	No
a	New power or natural gas systems or substantial alterations to existing systems?			x
b	New communications systems or substantial alterations to existing systems?			x
c	New water systems or substantial alterations to existing systems?			x
d	New storm or septic tank systems or substantial alterations to existing systems?			x
e	New storm-water drainage systems or substantial alterations to existing systems?			x
f	New solid waste disposal systems or substantial alterations to existing systems?			x
XVII	HUMAN HEALTH. Will the proposal result in:	Yes	Maybe	No
a	Creation of any real or potential health hazard (excluding mental health)?			x
b	Exposure of people to potential health hazards?			x
XVIII	ESTHETICS. Will the proposal result in:	Yes	Maybe	No
a	Obstruction of any scenic vista or view open to the public?			x
b	Creation of an esthetically offensive site open to public view?			x
XIX	RECREATION. Will the proposal result in:	Yes	Maybe	No
a	Impacts on the quality or quantity of existing recreational opportunities?		x	
XX	CULTURAL RESOURCES. Will the proposal result in:	Yes	Maybe	No
a	Alteration or destruction of a prehistoric or historic archaeological site?			x
b	Physical or esthetic effects on any prehistoric or historic building, structure, or object?			x
c	Potential physical change that would affect unique ethnic cultural values?			x
d	Restriction of existing religious or sacred uses?			x
XXI	MANDATORY FINDINGS OF SIGNIFICANCE.	Yes	Maybe	No
a	Potential to Degrade: Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal, or eliminate important examples of the major periods of California history or prehistory?		x	
b	Short-Term Goals: Does the project have the potential to achieve short-term environmental goals to the disadvantage of long-term goals? (A short-term impact on the environment is one that occurs in a relatively brief, definitive period. Long-term impacts will endure well into the future.)			x
c	Cumulative Impacts: Does the project have impacts that are individually limited but cumulatively considerable? (A project may affect two or more separate resources where the impact on each resource is relatively small but where the effect on the total of those impacts on the environment is significant.)		x	
d	Substantial Adverse Impacts: Does the project have environmental impacts that will cause substantial adverse effects on people, either directly or indirectly?			x

Impacts of Direct Purchase of Surface Water Stored in Reservoirs

A number of reservoir operators could be willing sellers of water to be transferred under the proposed Supplemental Water Purchase Program. In the Sacramento Valley, water for direct transfer could come from a variety of reservoirs on the Feather, Yuba, and American river systems. Based on previous Drought Water Bank sales, it is conceivable that water could also be sold from reservoirs in the San Joaquin Valley, such as Lake McClure on the Merced River, New Don Pedro on the Tuolumne River, and New Melones on the Stanislaus River. As a result of hydrologic conditions and constraints discussed below, and based on previous Drought Water Bank activities and other water transfers, the estimated maximum amount of water available for transfer from surface water sources is 200,000 acre-feet per year.

General environmental impacts that may result from the Supplemental Water Purchase Program relate to potentially lower water levels in participating reservoirs. This could lead to impacts to fish, recreation, carryover storage, and the inability to provide adequate streamflow to meet temperature requirements for aquatic life below the reservoir. To address these concerns, the Supplemental Water Purchase Program will require that prior to a water purchase from surface storage, the reservoir operators involved must show specific operating criteria and plans that indicate the amount of water that will be available for purchase.

Carryover Storage

Carryover storage could be significantly impacted as a result of single-year or consecutive-year water transfers from any of the reservoirs likely to be involved. Reservoirs could be drawn down farther with the proposed Supplemental Water Purchase Program than without it. All of the reservoirs likely to be involved in selling water to this program have minimum carryover storage criteria under which they strive to operate. If they choose to operate below these levels, their ability to meet future contractual obligations for water demands and minimum flow requirements downstream can be jeopardized. Indeed, if reservoir operators choose to ignore minimum operating levels and gamble on the facilities being replenished in a year or two by large amounts of precipitation, impacts of this program on carryover storage could be significant.

Potential impacts to participating reservoirs associated with reduced carryover storage would include lower water levels than without the transfer. Increased water temperature, lower dissolved oxygen levels, reduced fish spawning habitat, and impacts to shoreline vegetation could all be significant.

One concern with transfers involving surplus reservoir withdrawals is the potential adverse impacts that could happen to downstream water users, primarily the State Water Project and Central Valley Project as junior appropriators. These impacts, referred to as reservoir refill impacts, can occur as a result of the "hole" left in a reservoir resulting from a transfer. If this hole is filled in the future with runoff that would have reached the Delta absent the transfer during balanced or restricted conditions, the State Water Project and Central Valley Project may need to make additional, uncompensated reservoir releases to meet Delta water quality requirements

for which they are responsible. To avoid these adverse impacts, all water sales involving surface supplies will require sellers to refill their reservoirs the following year or years during excess conditions (high runoff periods) in the Delta. Alternatively, sellers could agree to pay the State Water Project and Central Valley Project back with water for any impacts that occurred while filling during balanced or restricted conditions. These developed criteria will be included in any contractual agreements between the seller and the Department of Water Resources, thus minimizing significant cumulative impacts.

The Department of Water Resources recognizes the potential benefits to reservoir and instream fisheries and other aquatic resources that could result from well-coordinated water transfers. The Department of Water Resources will work closely with the Department of Fish and Game and the participating sellers to optimize benefits that may result, for instance, from timing releases, ramping flows and storing water, and any other operations as export and operational conditions allow this flexibility.

Streamflow

Generally, increased streamflow as a result of water transfers under the proposed Supplemental Water Purchase Program could benefit fish and other aquatic life at certain times of the year by adding more water to streams at times of the year when these streams generally would be flowing at lower levels. Additional benefits, such as cooler water, increased oxygen levels, and improved water quality, could also result from these water transfers, benefiting those aquatic systems where water transfers take place. Riparian vegetation along streams used for transfers could also benefit from change in timing of releases.

Conversely, impacts to streamflow could result from reduced carryover storage cumulatively over a few consecutive years. If carryover storage were reduced to the point where minimum downstream releases could not be provided, this could result in inadequate streamflow, contributing to increased water temperature, lower dissolved oxygen levels, reduced cover and spawning habitat for warmwater fish, and reduced spawning habitat for coldwater fish in some of the feeder tributaries. Cumulatively, these impacts could be significant if they were to occur over a consecutive 6-year program.

Significant impacts to streamflow are closely tied to carryover storage in reservoirs operated on those streams. Overall, if carryover storage is not impacted during the life of the proposed Supplemental Water Purchase Program, cumulative impacts to streamflow as a result of consecutive transfers from participating reservoir systems could be beneficial.

Water Quality Impacts in the Sacramento Valley

In the Sacramento Valley (Figure 9), water for transfers could come from water agencies with water rights on the Feather, Yuba, or American rivers. On the Feather River (Figure 10), Oroville-Wyandotte Irrigation District stores water in Sly Creek and Little Grass Valley reservoirs, and Thermalito Irrigation District stores water in Concow Reservoir. Yuba County Water Agency stores water in New Bullards Bar Reservoir, and Browns Valley Irrigation District operates Collins Lake. Both contribute to Yuba River flows (Figure 10). On the upper American River, above Folsom Lake, Placer County Water Agency operates Hell Hole and French Meadows reservoirs (Figure 11). All of these contributed to the Drought Water Banks in one or more of the three years of operation.

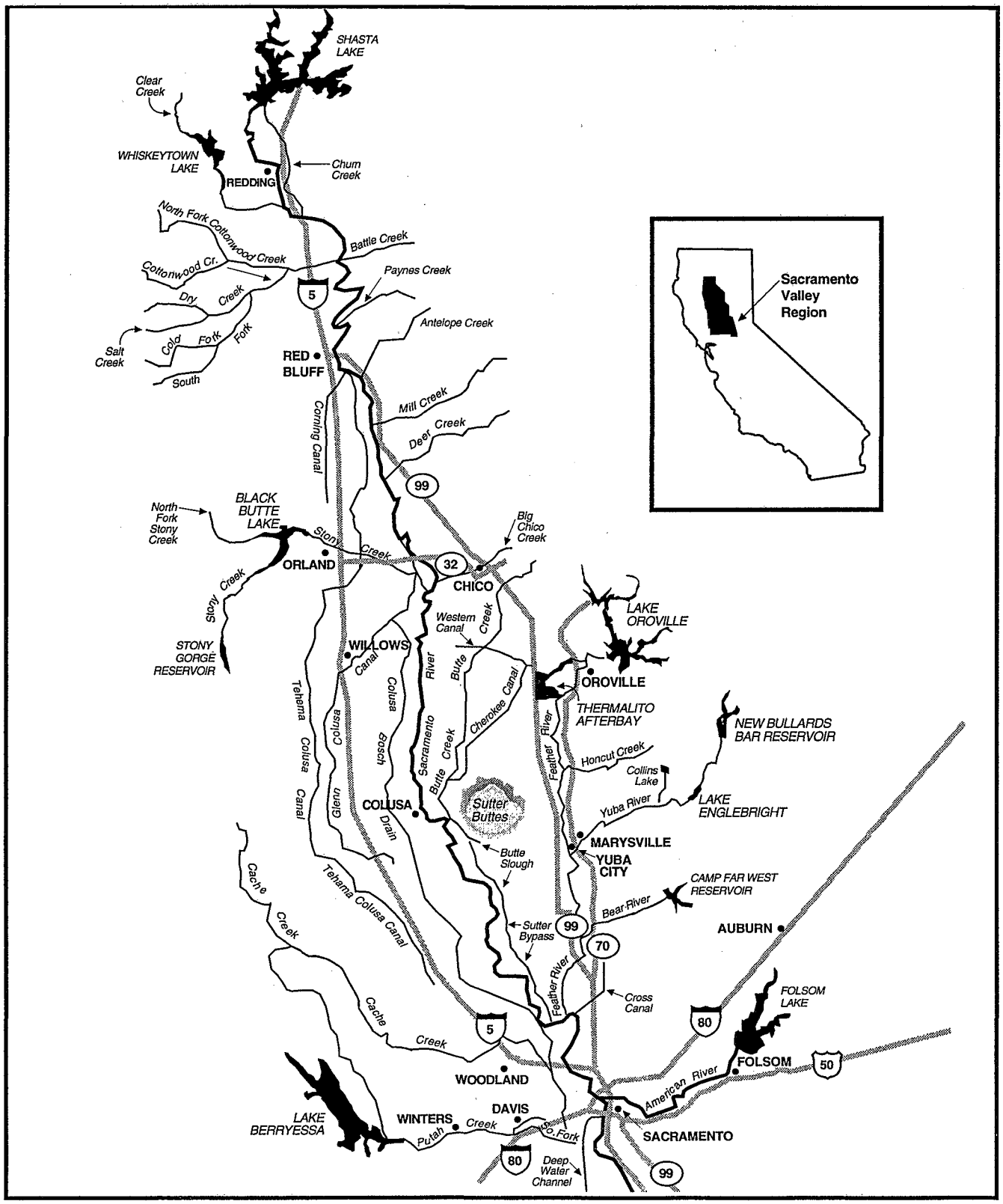

Figure 9
SACRAMENTO VALLEY REGION

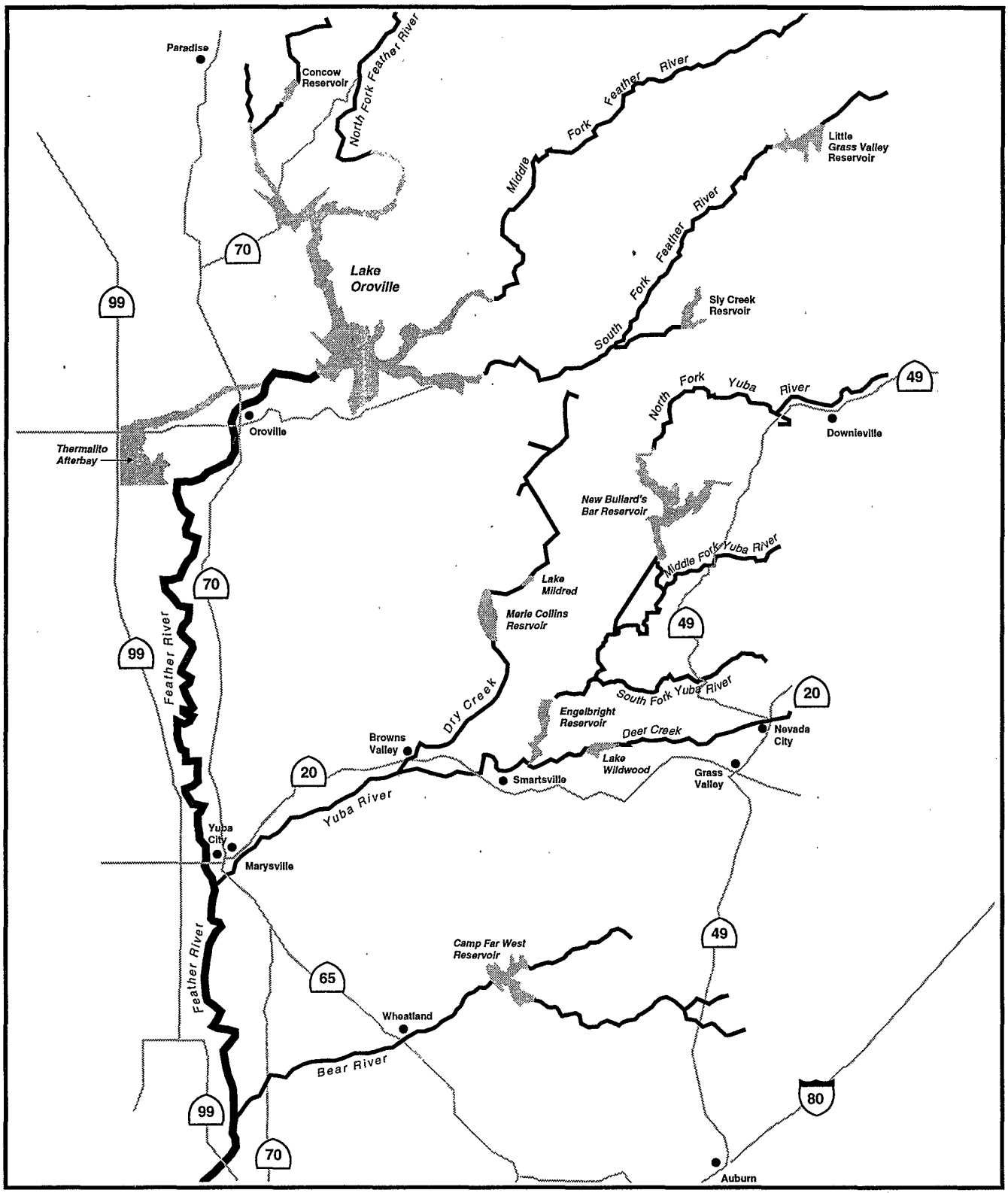

Figure 10
FEATHER, YUBA, AND BEAR RIVERS

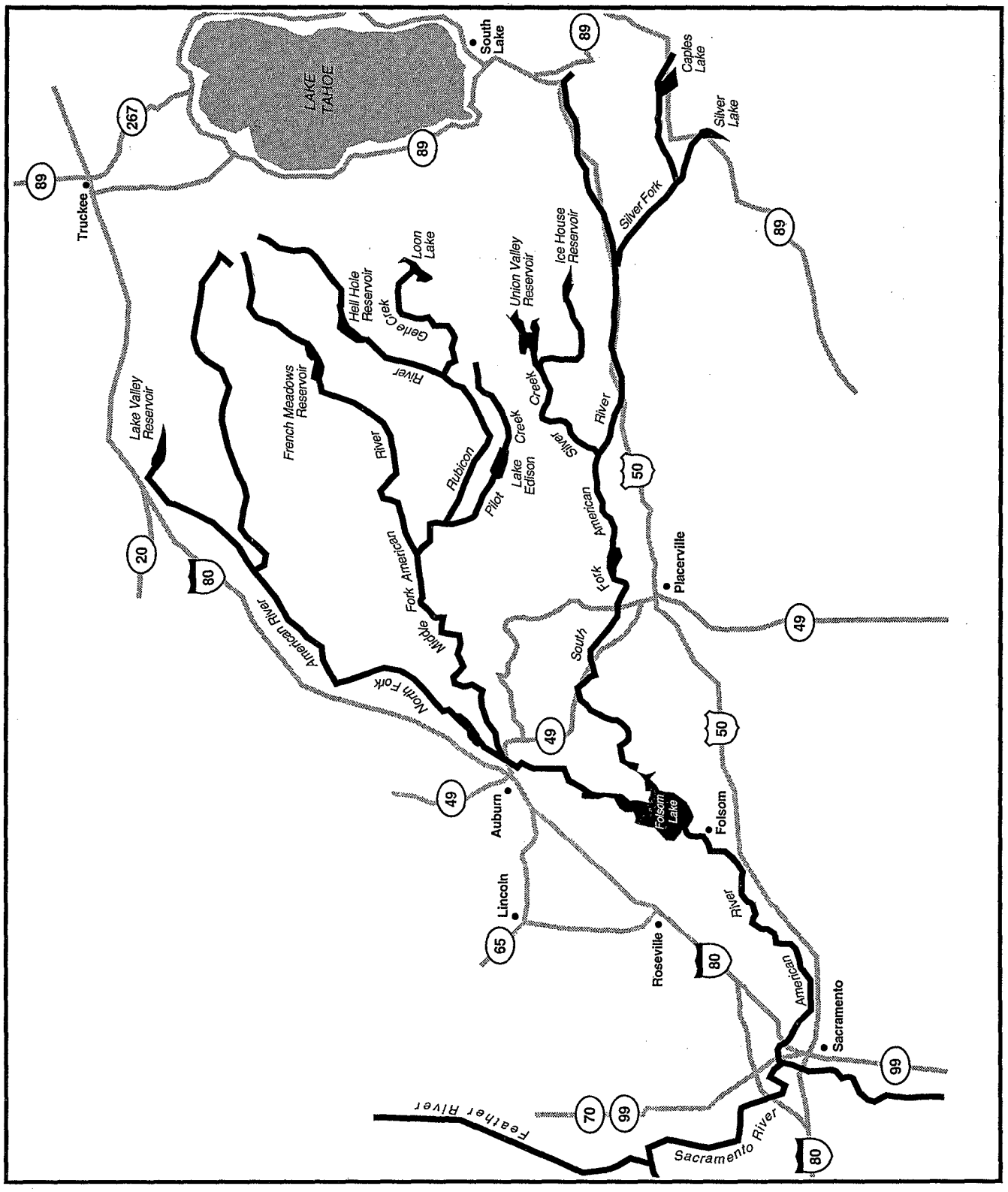

Figure 11
AMERICAN RIVER

Yuba River

Yuba County Water Agency, which sold water to the 1991 and 1992 Drought Water Banks and others, will not sell water unless it has enough in storage for a full local supply and enough to meet instream flow requirements under non-dry-year criteria. The agency has a minimum target reservoir storage level of 507,000 acre-feet (52% of capacity) in New Bullards Bar Reservoir to ensure that if the next year's hydrologic conditions are at 1977 levels, there will still be enough in storage to meet obligations.[3]

Figures 12, 13, and 14 compare the approximate end-of-month storage at New Bullards Bar Reservoir for a transfer of about 100,000 acre-feet for critical, dry, and below normal years, as well as storage levels without a transfer.[4] As indicated, little change in storage is expected in New Bullards Bar Reservoir at the end of the year. Water quality in New Bullards Bar Reservoir is not expected to be impacted by releases made to the proposed Supplemental Water Purchase Program. Although reservoir temperature could increase slightly as a result of lowered water volume, the levels and temperature are expected to stay within the historical range that has occurred during earlier drawdowns, and this program is expected to result in no significant impacts to water quality.

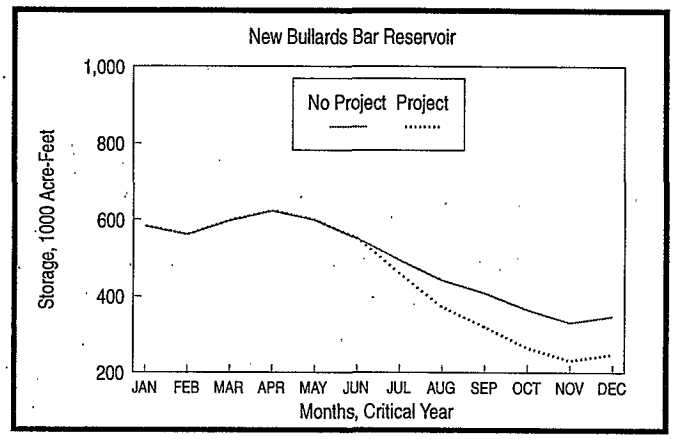

Figure 12
END OF MONTH STORAGE, NEW BULLARDS BAR RESERVOIR, WITH AND WITHOUT THE PROPOSED PROJECT, CRITICAL YEAR

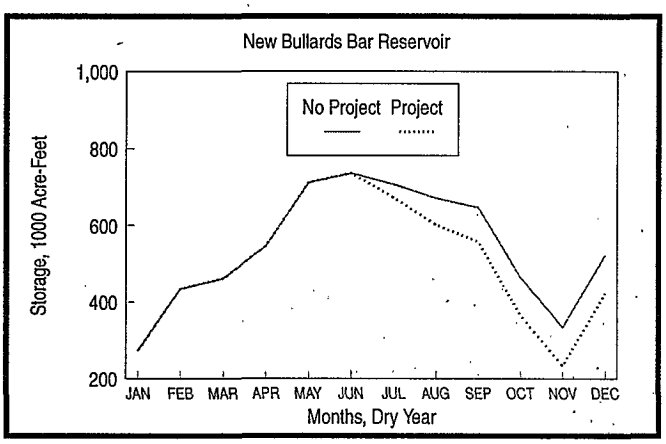

Figure 13
END-OF-MONTH STORAGE, NEW BULLARDS BAR RESERVOIR, WITH AND WITHOUT THE PROPOSED PROJECT, DRY YEAR

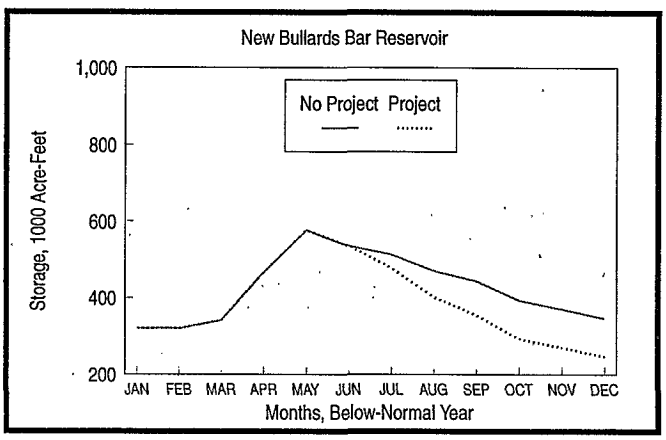

Figure 14
END-OF-MONTH STORAGE, NEW BULLARDS BAR RESERVOIR, WITH AND WITHOUT THE PROPOSED PROJECT, BELOW-NORMAL YEAR

3 Donn Wilson, Yuba County Water Agency, personal communication.
4 Reservoir storages are derived from actual hydrologic data in a DWRSIM study. The critical year is 1931, dry is 1949, and below-normal is 1945.

Feather River

A possible willing seller of stored surface water on the Feather River system is Oroville-Wyandotte Irrigation District, which uses Little Grass Valley Reservoir (on the South Fork Feather River) and Sly Creek Reservoir (on Sly Creek) and has an annual demand of 30,000 acre-feet. The Federal Energy Regulatory Commission requires fishery releases in the South Fork Feather River of 5 cubic feet per second from November 1 to April 30 and 10 cfs from May 1 to October 31. Dry-year criteria allow these flows to be cut in half. To ensure that it can meet its obligations, Oroville-Wyandotte Irrigation District does not allow Little Grass Valley Reservoir to drop below 44,000 acre-feet (45% of capacity) and 18,000 acre-feet at Sly Creek Reservoir (27% of capacity).[5]

Oroville-Wyandotte Irrigation District has participated in previous water transfers, including the 1994 Drought Water Bank, with 10,000 acre-feet being sold. Because of the locations of its two reservoirs (upstream of Lake Oroville), the district has more flexibility than other potential sellers to move the water into the State Water Project system.

Water quality in these two reservoirs is very good and is not expected to be impacted as a result of water transfers of up to 10,000 acre-feet from the proposed Supplemental Water Purchase Program. Previous water transfers did not result in adverse impacts to either water quality or water temperature in either reservoir; therefore, no significant impacts are expected.

Another potential seller is Thermalito Irrigation District, which owns and operates Concow Reservoir on Concow Creek, a tributary to the West Branch of the Feather River. With a capacity of more than 7,200 acre-feet, Concow Reservoir provides about 3,200 acre-feet annually to primarily domestic users in the Thermalito Irrigation District service area.

No water quality impacts are expected to Concow Reservoir as a result of a water transfer. Due to stringent requirements imposed by the Department of Fish and Game for temperatures required for bass spawning in the reservoir, no impacts to reservoir water quality would be expected from the proposed Supplemental Water Purchase Program.

American River

Placer County Water Agency operates Hell Hole Reservoir on the Rubicon River and French Meadows Reservoir on the Middle Fork American River. Through a contractual agreement, Pacific Gas and Electric Company actually controls reservoir releases as they pertain to hydroelectric power generation. Furthermore, releases from these two reservoirs ultimately enter the American River system and Folsom Lake, where the U.S. Bureau of Reclamation controls releases. Any sale of water from Placer County Water Agency must take into account measures to satisfy contractual arrangements as well as the Interim Operating Criteria currently in place for Folsom Lake.[6]

5 Steve Onkin, Oroville-Wyandotte Irrigation District, personal communication.

6 Sacramento Area Flood Control Agency and U.S. Bureau of Reclamation. 1994. *Interim Reoperation of Folsom Dam and Reservoir.* Final Environmental Impact Report. Sacramento.

Normal carryover storage for the two reservoirs combined is 140,000 acre-feet (90,000 for Hell Hole and 50,000 for French Meadows). The Department of Fish and Game recommends that releases from Hell Hole and French Meadows reservoirs be stored in Folsom Lake and held until mid- to late October.

Water quality in both Hell Hole and French Meadows reservoirs is generally very good. Transfers of water from these reservoirs resulting from the proposed Supplemental Water Purchase Program are not expected to impact water quality in these reservoirs or in Nimbus Reservoir.

Water Quality Impacts in the San Joaquin Valley

In the San Joaquin Basin (Figure 15), water for transfers would likely come from any of the three largest tributaries to the San Joaquin River — the Merced, Tuolumne, or Stanislaus rivers (Figure 16). All three have large reservoirs that store water for local agricultural, municipal, and industrial use. In recent years, especially drought years 1987-1992, these reservoirs were drawn down to low levels. This resulted in a variety of environmental problems affecting fish, recreation, and both agricultural and municipal water users. These problems were related to an overall lack of water, particularly in summer and fall.

Low summer and fall flow in the San Joaquin River system were especially detrimental to anadromous fisheries.

In general, surface water transfers in the San Joaquin system could improve flow and water quality in tributaries to and the mainstem San Joaquin River.

Merced River

Merced Irrigation District owns and operates New Exchequer Dam on the Merced River. In previous years, the district has transferred water to the Department of Fish and Game and Westlands Water District. Water released from Lake McClure flows down the Merced River, into the San Joaquin River, and into the Delta. Merced Irrigation District stores water in Lake McClure to meet irrigation demand, which averages about 500,000 acre-feet annually. Historically, low flows below Crocker-Huffman Dam have contributed to less-than-optimum conditions for many life stages of fall-run chinook salmon, including temperature, spawning habitat, and water quality problems.[7] Minimum releases from Lake McClure at various times of the year are dictated by Federal Energy Regulatory Commission license 2179 and Davis-Grunsky agreement D-GGR17 (DWR 160282). Irrigation obligations and Article 44 of its FERC license require that Merced Irrigation District not drop below a minimum storage level of 115,000 acre-feet in Lake McClure past November 1 of each year. Existing minimum instream flow requirements for the Merced River, measured at Shaffer Bridge, are (in cubic feet per second):

7 San Joaquin River Management Program. 1993. *An Action Plan for San Joaquin Fall-Run Chinook Salmon Populations.*

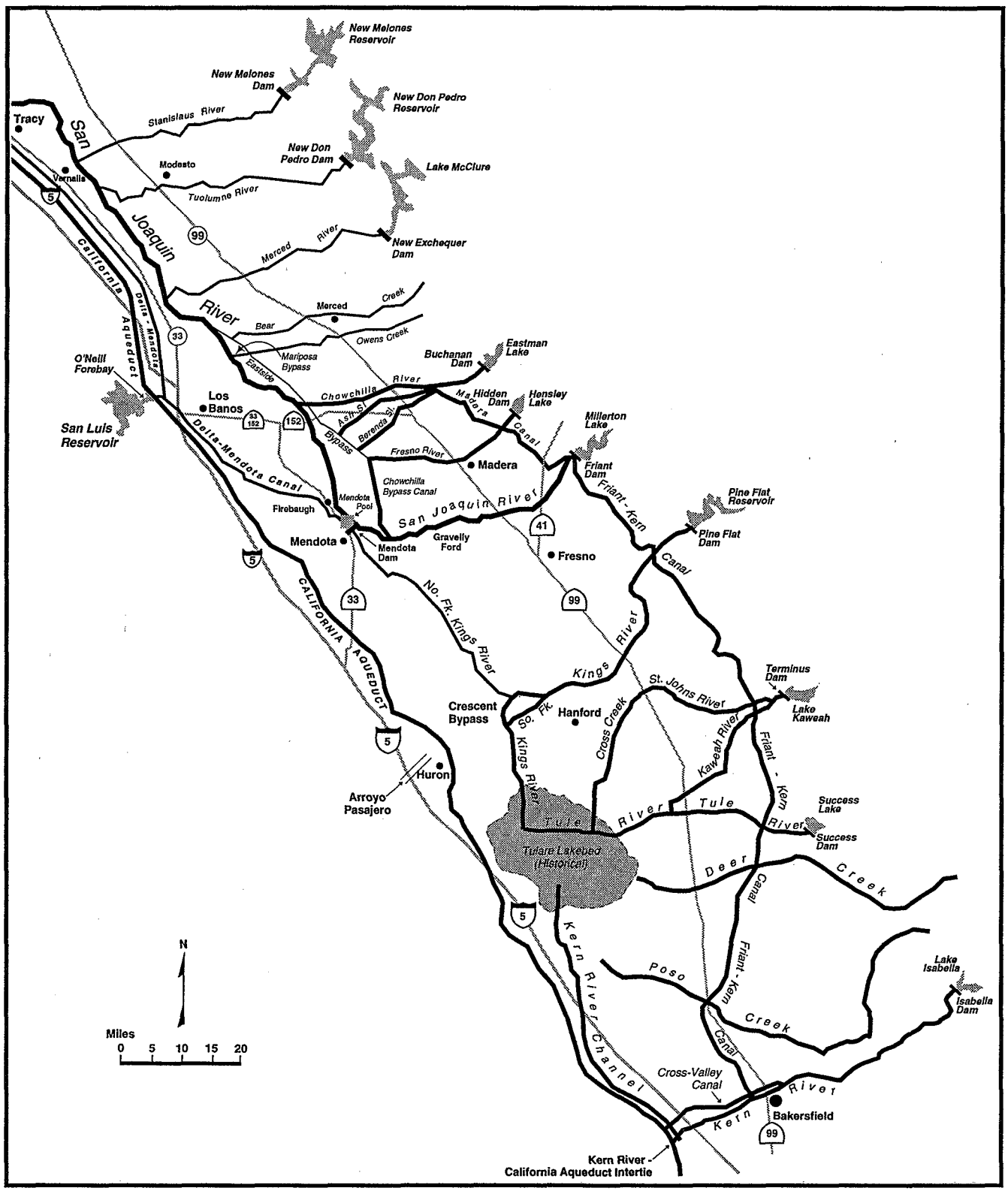

Figure 15
SAN JOAQUIN VALLEY REGION

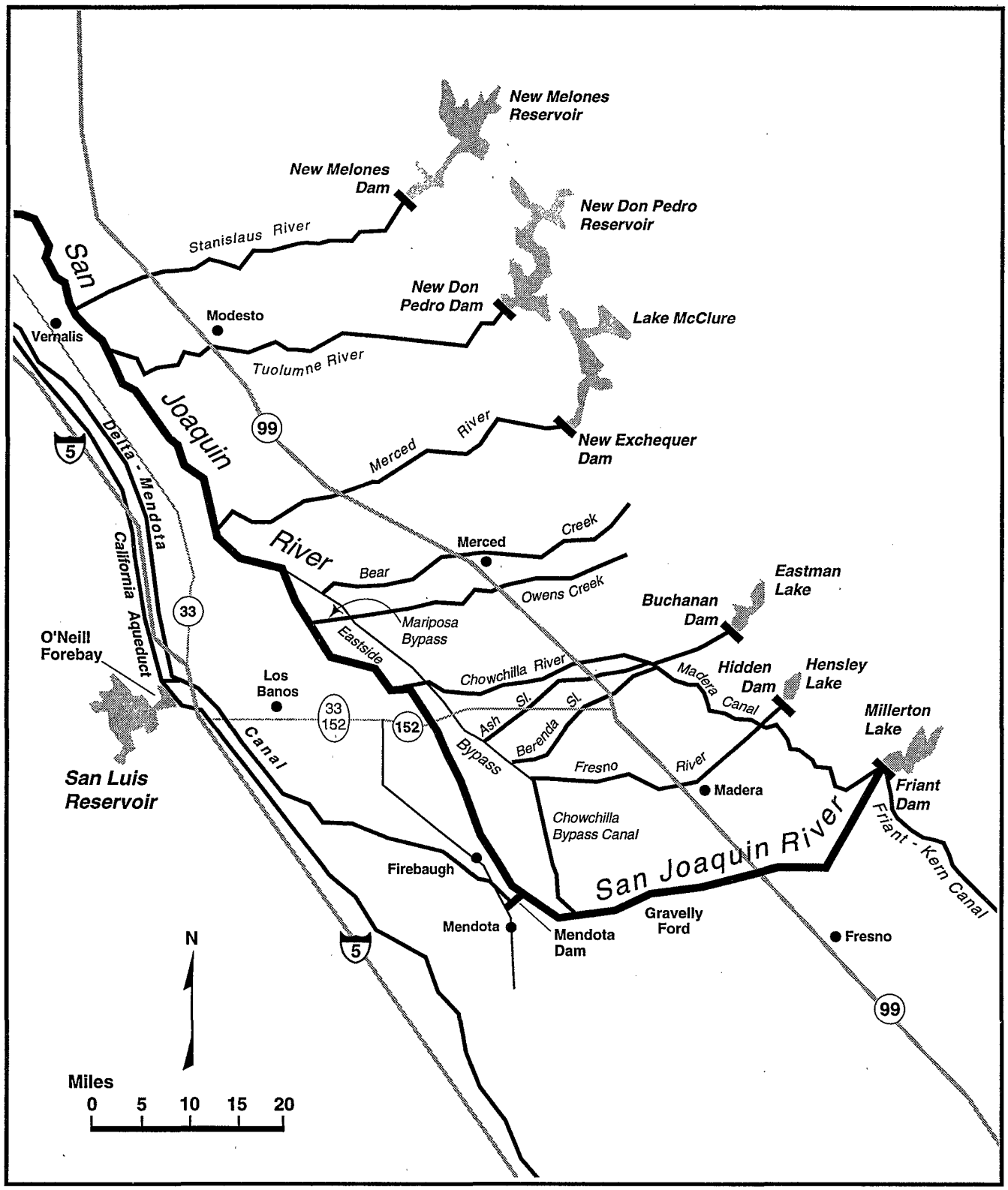

Figure 16
SAN JOAQUIN RIVER AND TRIBUTARIES

	Normal Year	Dry Year
June 1 - October 15	25	15
October 16 - October 31	75	60
November 1 - March 31	220	180
April 1 - May 31	75	60

Water quality in Lake McClure is generally very good. Assuming Merced Irrigation District adheres to minimum reservoir criteria of 115,000, water quality in the reservoir will not be impacted as a result of transfers under the proposed Supplemental Water Purchase Program, because reservoir levels are expected to be well within the historical range.

Tuolumne River

The major storage facility on the Tuolumne River is Lake Don Pedro, created by Don Pedro Dam, which replaced Old Don Pedro Dam in 1971. The Don Pedro Project is owned by Turlock Irrigation District (68.46%) and Modesto Irrigation District (31.54%); Turlock Irrigation District is the project manager. The two districts have a combined annual demand of 900,000 to 1,100,000 acre-feet for irrigation and municipal and industrial purposes, with the higher diversions occurring during drier water years. Water is allocated between the districts based on the 68.46/31.54 percent split. The districts have a minimum reservoir carry-over storage target of 391,000 acre-feet of active storage in Don Pedro Reservoir.

In 1913, Congress passed the Raker Act (38 Stat. 242), which authorized the Secretary of the Interior to grant rights-of-way to the City and County of San Francisco to build several water supply and power facilities on the upper Tuolumne River. A condition of the authorization obligated San Francisco to recognize the pre-1914 water rights of the irrigation districts. The pre-1914 water rights of San Francisco are to Tuolumne River floodflows.

By contributing to construction costs of "New" Don Pedro Reservoir in 1971, the City and County of San Francisco acquired a "water bank" in Don Pedro Reservoir equal to 570,000 acre-feet of the reservoir's storage plus up to 170,000 acre-feet of the reservoir's flood control space during the non-flood-control season. The water bank enables San Francisco to release water to the irrigation districts in advance of the time when San Francisco would be required to release water to the districts under the districts' senior water rights and under the Raker Act. The Don Pedro water bank allows the City and County of San Francisco to build up credits in the water bank by releasing or spilling water from its upper Tuolumne reservoirs to Don Pedro Reservoir in amounts over and above the districts' rights. Diversions by San Francisco of the districts' water entitlements would result in a debit to the water bank account. If the water bank account went negative, San Francisco would be required to resume required releases until a positive balance in the account was restored. The City and County of San Francisco has no ownership interest in any water in Don Pedro Reservoir or in the water bank.

To the extent of its water bank credits, the City and County of San Francisco is allowed to divert water to which the districts would otherwise be entitled under their senior water rights. During dry water cycles, if San Francisco has built up its water

bank credits during preceding water years, Don Pedro Reservoir may appear at times to be "fuller" relative to other Eastside reservoirs. The additional water in the reservoir is the water on which the districts would have to rely for the following year, because San Francisco would have the contractual right to intercept and divert the districts' water up to the amount of its water bank credit. For example, during water year 1976, because of its water bank credits, the City and County of San Francisco was able to divert some 253,000 acre-feet[8] of the 395,000 acre-feet of unimpaired Tuolumne River flow, with the districts receiving only about 142,000 acre-feet of water.

Water quality in New Don Pedro Reservoir is generally good, even during periods when water levels are low. No water quality or water temperature impacts to the reservoir are expected, since any Supplemental Water Purchase Program transfer from New Don Pedro Reservoir would likely be small. Thus, any impacts to temperature and water quality would not likely be seen.

Stanislaus River

The major storage reservoir on the Stanislaus River, New Melones Reservoir, was constructed by the U.S. Army Corps of Engineers in 1979. The U.S. Bureau of Reclamation now operates the reservoir as part of the Central Valley Project.

The capacity of New Melones Reservoir is 2.42 million acre-feet. The settlement agreement between the U.S. Bureau of Reclamation, Oakdale Irrigation District, and South San Joaquin Irrigation District requires the Bureau of Reclamation to provide up to 600,000 acre-feet to the two irrigation districts from New Melones Reservoir. Also, a 1987 agreement between the Department of Fish and Game and the Bureau of Reclamation requires a minimum annual release of 98,300 acre-feet for fish flows in the river and 70,000 acre-feet to meet water quality standards at Vernalis. During recent years, the Bureau of Reclamation, Fish and Game, and U.S. Fish and Wildlife Service have coordinated releases of flows that exceeded 98,300 acre-feet when additional water was available. These efforts would be expected to continue, when hydrologic conditions allow for increased releases.

In addition to these obligations, the Bureau of Reclamation has contractually agreed to provide 49,000 acre-feet firm and 31,000 acre-feet interim water to Central San Joaquin Irrigation District and 75,000 acre-feet interim water to Stockton-East Water District.

All these demands on New Melones water have exceeded the available yield. The Central Valley Project Improvement Act could also play a role in water availability from New Melones. Under CVPIA, 800,000 acre-feet of water must be made available for fish and wildlife needs. Because there is no yield available in New Melones, in 1994 the Bureau of Reclamation purchased 50,000 acre-feet from Oakdale and South San Joaquin irrigation districts to provide spring and fall pulse flows for chinook salmon in the San Joaquin Basin.

8 The average total annual demand of the City and County of San Francisco for its in-city and Bay Area customers is about 300,000 acre-feet. The City and County of San Francisco has Don Pedro water bank storage of 740,000 acre-feet, upper Tuolumne River storage of 661,800 acre-feet, and Bay Area storage of 224,800 acre-feet, for a total reservoir storage capacity of 1,626,600 acre-feet.

The Bureau of Reclamation is negotiating with the two irrigation districts to purchase water for spring and fall pulse flows and will be looking at a possible longer-term arrangement for future additional flows.

Water transfers could provide significant benefits to water quality in the Stanislaus River and in the southern Delta, such as reduced temperature, higher dissolved oxygen, and lower salinity. During certain times of the year, especially summer and late fall, water quality conditions can be poor in the lower Stanislaus River and San Joaquin River near Vernalis. High temperature, low dissolved oxygen levels, and increasing salinity (resulting from natural flow diversions and drainage flows) all combine, resulting in poor water quality in this area.[9] Well-coordinated releases could assist in meeting water quality standards at Vernalis, thus allowing the U.S. Bureau of Reclamation to hold water for later use in New Melones.

Water could be available for transfer under the proposed Supplemental Water Purchase Program from Oakdale and South San Joaquin irrigation districts who, in 1992, sold 50,000 acre-feet of water to the Drought Water Bank. Future transfers under the proposed program could be of this same magnitude and would likely be in direct competition for other uses, including the Central Valley Project Improvement Act.

Impacts of Groundwater Substitution

Groundwater substitutions for the Supplemental Water Purchase Program will be conducted only in the Sacramento Valley and in the vicinity of the Sacramento-San Joaquin Delta. Potential transfers from the San Joaquin Valley groundwater will not be considered for the program due to long-term overdraft in some areas there and potential impacts on surface water flows. Impacts of groundwater substitution for the proposed Supplemental Water Purchase Program can only be estimated because the Sacramento Valley aquifer system is complex and not fully understood. Potential impacts will vary from place to place depending on: the number of years in which groundwater extraction occurs; whether groundwater extraction occurs in a single year or a series of consecutive years; and weather and run-off conditions during the groundwater extraction years and subsequent years. Currently, there is a lack of analytical tools, such as calibrated and verified groundwater models, to quantify groundwater extraction impacts in most areas of the Sacramento Valley. In the absence of such tools, impacts estimated below have been derived from experience with similar groundwater substitution programs in the 1991, 1992, and 1994 Drought Water Banks. Actual operations will be guided by real-time monitoring of pumping and groundwater levels.

The discussion of groundwater impacts is based on the extreme and relatively unlikely possibility that groundwater extraction would occur in all six contract years at a rate equal to previous maximum Drought Water Bank extraction levels. In reality, the maximum amount of groundwater substitutions will be restricted to historical maximum Drought Water Bank extraction levels in extremely dry years when

9 State Water Resources Control Board. *Water Quality Control Plan Environmental Report.* 1995.

program purchasers need water the most. Because adequate or nearly adequate water supplies will be available to program users in most years, the need for groundwater extractions would be reduced then and potential impacts would be less than presented below.

This section describes potential impacts to groundwater levels, water quality, surface water / groundwater interaction, and subsidence in areas where groundwater substitutions may occur under the proposed Supplemental Water Purchase Program. Mitigation measures have been identified, where appropriate, to offset significant impacts.

Groundwater Levels

The proposed groundwater substitution programs will be conducted with a variety of willing water agencies, most of which have participated in past Drought Water Bank programs. The identification of water level impacts is based on analysis of the 1991, 1992, and 1994 Drought Water Bank groundwater substitution programs in the Sacramento Valley. Since annual program extractions will be limited to amounts that occurred in past Drought Water Bank programs, the analysis of past impacts provides a reasonable measure of the expected future impacts. To the extent that other districts participate in future Supplemental Water Purchase Program groundwater substitutions, their impacts are estimated to be similar to those that have occurred in areas that participated in the past Drought Water Bank programs. Because of variations in hydrogeologic conditions between northern and southern Sacramento Valley, water level impacts are discussed separately for those two areas.

Northern Sacramento Valley

Groundwater levels in irrigated areas of the northern Sacramento Valley that may participate in the Supplemental Water Purchase Program generally range from about 10 feet or less below the surface to about 20 feet below the surface in some of the northern, eastern and western edge areas. Measured depths to groundwater in some wells range from about 30 feet in areas near the Sacramento River to as much as 100 feet in other areas farther away from the river. Wells in the northern Sacramento Valley rely on what appears to be a leaky aquifer system made up of an unconfined upper aquifer and a semiconfined-to-confined lower aquifer. Typically, domestic wells have shallow depths and access only the upper aquifer. Irrigation wells normally produce from the lower aquifer or a combination of the lower and upper aquifer.

Wells that will be used in the groundwater substitution program are predominately irrigation wells yielding water from the lower aquifer. This lower aquifer is recharged near the foothills and with leakage from the upper aquifer. Some other irrigation wells that may participate in the groundwater substitution program are perforated in both the shallow and deep aquifers and, thus, allow water to move from the upper to the lower aquifer. Because the lower aquifer is semiconfined to confined, the groundwater levels show greater seasonal change (up to 100 feet). These changes reflect pressure changes in the aquifer; the actual groundwater being removed from storage is much less.

Monitoring during the 1991, 1992, and 1994 Drought Water Banks demonstrated that groundwater levels in participating areas recovered each spring from the previous

summer's extraction in both the shallow and deep aquifers. Also, monitoring showed shallow domestic wells were not impacted by extractions from the deeper irrigation wells during extraction periods. The upper unconfined aquifer receives recharge from precipitation, creeks, water storage facilities like Thermalito Afterbay, and deep percolation of applied irrigation water. These sources keep this upper aquifer full, as reflected in groundwater levels that show little seasonal change. Any change that does occur is after the rice fields are drained and before the winter rains begin. During this period, groundwater levels can drop a few feet.

During the 1994 Drought Water Bank, the Department of Water Resources received reports that groundwater levels immediately east of Western Canal Water District, an area known as the "Cherokee Strip", had dropped to the point of reducing well yields and causing the bowls in at least one pump to be lowered. Similar allegations were made about "impacts" in the Durham area, to the north of Western Canal Water District. The Department met with some of the growers along the Cherokee Strip and expanded the monitoring grid to determine what impacts, if any, the substitution program was having on wells there. In addition, Western Canal Water District growers adjacent to the Cherokee Strip agreed to turn off six of the closest pumps. If program participant wells were responsible, the groundwater levels should have recovered tens of feet with the reduction in extraction, but after a couple of weeks, little to no recovery was documented. Western's growers agreed to turn off additional pumps, which caused the groundwater levels to rise up to 40 feet in the service area, but there was still little recovery along the Cherokee Strip. Growers agreed to keep these pumps turned off until the end of almond irrigation in early August. After the almond harvest began, growers began turning the pumps back on.

The Department's preliminary analysis of the monitoring data from Drought Water Bank activities in Western Canal Water District is that:

- Groundwater pumping associated with the 1994 Drought Water Bank did not significantly impact groundwater levels in the Durham area.
- Groundwater pumping associated with the 1994 Drought Water Bank resulted in about 10 feet of additional drawdown for the Cherokee Strip area. This additional drawdown appears to be limited to a half-mile radius of wells participating in the Drought Water Bank.
- Impacts on the Cherokee Strip area from Western Canal Water District substitution pumping, although still unknown and difficult to determine, depend on individual well data: well construction, pump efficiency, current and historical static groundwater levels, and current and historical groundwater levels during pumping.

Western Canal Water District and the Department of Water Resources evaluated the data to identify the impact of groundwater substitution programs on problems noted in the Cherokee Strip area. Landowners impacted by the groundwater substitution program were offered an energy allowance to mitigate for increased pumping costs.

Two measures will be employed to mitigate for possible impacts on groundwater levels. First, participating wells will be spaced at least a half-mile apart to minimize potential water level declines. Restricting the well spacing will distribute pumping impacts over a wider area and lessen water level declines. Second, selected irrigation

and domestic wells within 2 miles of the substitution program will be monitored monthly for water level declines. If declines are detected of greater than 10 feet over average historical summer drawdown for a given area, the substitution program pumping impacts will be thoroughly reviewed. If the declines can be attributed to the substitution program, pumping will be reduced or shifted to reduce declines to less than 10 feet over average historical summer drawdown, or the affected pumpers will be offered financial compensation equal to identified pump and well modification costs and increased energy costs.

Southern Sacramento Valley

Areas in the southern Sacramento Valley that participated in past Drought Water Bank programs are Yuba County Water Agency, western Sutter County, Conaway Conservancy and other landowners in Yolo County, and eastern Contra Costa County. Groundwater conditions in those areas were monitored during Drought Water Bank groundwater substitution programs to identify possible impacts of those programs. These impacts are described below.

Overall, potential impacts on local groundwater users from the proposed Supplemental Water Purchase Program in the southern Sacramento Valley may be somewhat different than those to the north. Historically, groundwater use has been more extensive in portions of the southern Sacramento Valley. Depth to groundwater is deeper in many areas, and the range of water levels is much broader (deeper and shallower) than what is found in the north. As a result, wells in portions of the southern Sacramento Valley are deeper and able to draw water over a wider range of groundwater levels. Although project extractions could cause increased drawdowns that will increase groundwater extraction costs, there is a reduced potential for groundwater levels in wells to drop below pump settings in the southern Sacramento Valley if extraction rates are held to historical Drought Water Bank levels.

In Yuba County, extensive use of groundwater for irrigation south of the Yuba River resulted in a deep pumping depression that started to develop in the mid-1940s and continued to enlarge and deepen until about 1985. In that year, Yuba County Water Agency began surface water deliveries to Brophy and South Yuba water districts. Before 1985, groundwater levels south of the Yuba River were declining at a rate of about 2 feet per year and reached a historical low of about 40 feet below sea level near Beale Air Force Base. In subsequent years, groundwater levels recovered about 6 feet per year, reaching a high of about 10 feet above sea level in 1990.

The 1991 Drought Water Bank extraction in the south half of Yuba County provided some insight to how extraction by the proposed program might impact groundwater levels. During 1991, 53,000 acre-feet of groundwater was extracted for the Drought Water Bank. This extraction caused groundwater levels in areas of concentrated pumpage to decline to nearly the 1985 level. Based on this information and the pre-1985 rate of average annual groundwater level decline, groundwater levels would be expected to decline about 10 feet below historical low levels, to an elevation of about 50 feet below sea level at the lowest point. Following the end of the program, groundwater levels would likely recover 6 feet or more annually. Many of the wells in southern Yuba County were installed before the 1985 groundwater level recovery, so most should be deep enough to remain functional during proposed program

extractions. However, the cost of extracting groundwater will increase with the increased pump lift.

North of the Yuba River, much less groundwater has been extracted historically, so groundwater levels there have remained much higher. During the 1991 Drought Water Bank, 26,300 acre-feet of groundwater was extracted in the northern portion of Yuba County, causing groundwater levels to decline about 40 feet, to a low of about 35 feet above sea level by the end of the irrigation season.

Throughout the irrigation season, there were no reported instances of water levels in irrigation wells being drawn down below the pumps. Monitoring of wells serving individual residences in a rural subdivision in Yuba County identified lowering water levels, so the extraction program was modified to resolve the problem. Groundwater levels recovered almost completely to pre-Water Bank levels by the start of the next irrigation season. Based on this information, proposed program extractions should have little lasting effect on long-term groundwater levels. In 1994, about 21,000 acre-feet of groundwater was extracted for the Drought Water Bank. Groundwater levels declined as a result, but not to 1991 levels, and recovered to pre-extraction levels by the next irrigation season.

There was only one complaint as a result of 1994 Water Bank activities in northern Yuba County. One landowner contended that the Water Bank extraction lowered water levels in his domestic well to the point where he had to have his well deepened. An evaluation of monthly countywide groundwater level data collected as part of the Water Bank revealed that groundwater levels in this area were lowered as a result of extraction outside the county and the lower levels were not attributable to the Water Bank.

In western Sutter County, groundwater use has been limited. During the 1991, 1992, and 1994 Drought Water Banks, roughly 2,000 acre-feet of groundwater was extracted. Groundwater level monitoring in the area revealed that during extraction periods, the groundwater levels decline nearly 100 feet due to the confined nature of the aquifer system. The monitoring also showed that following the extraction periods, groundwater levels completely recovered before the next irrigation season. Moreover, water levels in adjacent wells were not significantly impacted by the extraction. Based on the monitoring data, it appears that any future multi-year extraction should have little lasting impact on groundwater levels in western Sutter County.

About 29,000 acre-feet of groundwater was extracted in Yolo County during the 1991 Drought Water Bank. This amount was increased during the 1992 Water Bank to about 42,000 acre-feet. Eastern Yolo County participated in the 1994 Water Bank, but groundwater extraction was scaled back to about 13,000 acre-feet.

Monthly groundwater level data collected during Drought Water Banks in eastern Yolo County show that groundwater levels recover rapidly following an extraction cycle and generally return to pre-extraction levels before the start of the next irrigation season. Based on this information, extraction under the proposed program should have little lasting impact on groundwater levels. Moreover, wells in the area are deep enough to remain functional at expected groundwater levels.

The Department of Water Resources recently completed a conjunctive use study for the eastern portion of Yolo County.[10] During that study, a reconnaissance-level groundwater flow model was developed for the region. One of the conjunctive use modeling scenarios included extraction of groundwater over a period of 6 consecutive years. The extraction was specified to occur only during the regular irrigation season, and the aquifer system then was allowed to partially recover by natural recharge until the start of the next irrigation season. Results from this modeling study generally indicate how the aquifer system in eastern Yolo County might behave during a worst-case extraction cycle under the proposed Supplemental Water Purchase Program. The model results show that average regional groundwater levels following the 6-year extraction cycle were about 30 feet lower than normal. The model predicted that the lowest groundwater levels would be east of Davis, where groundwater levels would be from 10 to 20 feet below sea level.

In eastern Contra Costa County, only limited extraction (2,500 acre-feet) occurred as part of the 1991, 1992, and 1994 Drought Water Banks. Groundwater level measurements show that water levels are not dramatically affected by extraction at previous rates and that water levels generally recover by the start of the next irrigation season. Based on this information, extraction under the proposed program should have little lasting impact on groundwater levels in eastern Contra Costa County.

As with the Northern Sacramento Valley, two measures will be employed to mitigate for possible impacts on groundwater levels. First, wells participating in the project will be restricted to a well spacing of a half-mile to minimize potential water level declines. Second, selected irrigation and domestic wells within 2 miles of the substitution program will be monitored monthly for water level declines. If declines are detected of greater than 10 feet over average historical summer drawdown for a given area, the substitution program pumping impacts will be thoroughly reviewed. If the declines can be attributed to the substitution program, pumping will be reduced or shifted to reduce declines to less than 10 feet over average historical summer drawdown, or the affected pumpers will be offered financial compensation equal to identified pump and well modification costs and increased energy costs.

Water Quality

Groundwater quality in most areas of the Sacramento Valley is generally very good, although there are localized areas of shallow saline water or elevated concentrations of naturally occurring trace elements and ions such as boron, arsenic, and manganese.

During prior Drought Water Bank extraction programs, supplemental groundwater quality monitoring was conducted to identify possible project impacts. Groundwater quality monitoring during the 1991 Water Bank revealed no degradation in water quality over the course of the irrigation season. As a result, water quality monitoring was scaled back in subsequent water banks. Limited monitoring in 1994 in the Western Canal area showed that water quality actually improved (up to 200 mg/L reduction in TDS) in most wells, which may be the result of aquifer flushing due to increased use. Total dissolved solids in pumped groundwater in the Durham and North Chico

10 Department of Water Resources. 1994. *SWP Conjunctive Use — Eastern Yolo County.* Memorandum Report.

areas increased (less than 65 mg/L increase) in 1994. Because there were no groundwater extractions by the Drought Water Bank programs in these areas, the increased TDS values in wells apparently was not caused by the extractions.

Based on water quality test results from previous water banks, extraction by the proposed Supplemental Water Purchase Program should cause no adverse impacts on groundwater quality, provided these extractions occur at similar locations and at extraction rates that do not exceed those of the water banks. Although extraction by the proposed program is not expected to impact groundwater quality, a more comprehensive water quality monitoring program will be undertaken to assure that problems do not develop.

Selected irrigation and domestic wells within 2 miles of wells pumped for the substitution program will be monitored monthly for specific conductance. Supplemental, general mineral analyses will be conducted for wells where pumped water exceeds the 250 microSeimens per centimeter limit for water classified as excellent for irrigation.[11] If water quality degradation is detected that could result in groundwater exceeding standards for beneficial use, the potential impacts of program pumping on those increases will be reviewed. If the substitution program contributes to the measured degradation in groundwater quality, pumpage will be reduced or shifted to curtail degradation.

Subsidence

In the Sacramento Valley, land subsidence has been documented in some areas. The most prominent of these areas is northeastern Yolo County, where land has subsided as much as 6 feet since the late 1940s. The subsidence area is near a group of Water Bank participants, but no permanent subsidence was detected during previous Drought Water Bank activity. Evaluation of subsidence records and corresponding groundwater levels in areas where subsidence is known to occur reveals that the subsidence is initiated when groundwater levels approach historical lows. Based on this observation and the assessment that potential groundwater level declines in areas where extraction might occur under the proposed program are minimal, it is considered unlikely that program extractions could initiate some level of subsidence.

Subsidence can be prevented by assuring that groundwater levels do not drop below historical low levels. In areas where extractions by the proposed program could cause groundwater levels to drop to new lows, subsidence will be monitored. The approach used for monitoring could include installing extensometers, performing conventional or global positioning system surveying, and reviewing water level measurements to identify periods when water levels could drop below historical lows. When subsidence has been identified or appears to be imminent based on the water level measurements, extractions for the program will be reduced or moved to avoid subsidence impacts.

11 ASCE Manual 40. *Ground Water Management.* Third Edition. 1987.

Surface Water / Groundwater Interaction

In many groundwater basins, including much of the Sacramento Valley and northern San Joaquin basins, surface water and groundwater are hydraulically interconnected. Changes in conditions of either may affect the other. Under the proposed Supplemental Water Purchase Program, groundwater substitution will result in either a temporary reduction in groundwater storage or a reduction in the amount of surface water flow at some point in time. In some cases, extraction could reduce the amount of groundwater that would be evaporated or used by plants in areas with shallow water and not directly affect streamflow. In general, it is not possible to accurately predict or measure the rate, place, or timing of changes to surface flow in the absence of site-specific data that often does not exist.

Because the processes of groundwater hydrology are difficult and costly to measure, the movement of water between surface streams and groundwater is poorly understood. Consequently, the ability to predict the impacts of a groundwater substitution program is limited.

Two basic approaches are available to estimate the effects on surface water. These approaches are, at times, combined into groundwater models that can be used to predict the rate and timing of impacts on surface water sources. They are no better than the data and assumptions that go into them.

The first approach involves constructing conceptual water balances for the areas affected, in which upper and lower bounds are estimated for those elements of the balance that cannot be measured: subsurface inflows, surface return flows, recharge of applied water, use by phreatophytes and other vegetation, and other elements. This approach can be applied to specific project sites, but it is more appropriate to a regional analysis.

The second approach is more appropriate to specific project locations and involves installation of monitoring well networks, testing aquifer properties, and developing other monitoring programs. The information would be used to establish the gradients that control movement between surface water and groundwater. This approach can provide more accurate estimates of the effect of specific groundwater substitution projects.

Because potential reductions to surface water flows would be small relative to the total amount of flow in area channels and because these reductions could occur for an extended period after pumping is completed, these potential impacts are difficult to measure directly. During the 1991, 1992, and 1994 Drought Water Bank programs, no noticeable reduction in surface water flow was attributed to groundwater substitution activities in the northern Sacramento Valley. At one location in the lower Sacramento Valley, use of some wells during the 1992 Drought Water Bank resulted in streamflow depletion. Department of Water Resources studies concluded that about one-third of the total groundwater extracted from these wells was, in fact, water depleted from the river. The contract with the Drought Water Bank participant was subsequently modified to reduce the amount of groundwater credited during the substitution.

Since reductions in surface water flow primarily affect the State Water Project and Central Valley Project by requiring increased reservoir releases to meet streamflow requirements, the Department of Water Resources is directly interested in minimizing impacts to surface water flow, regardless of whether those impacts can be directly

measured. Correspondingly, future groundwater substitution programs will be monitored and reviewed annually to indirectly determine through a water balance analysis the quantity of potential surface water flow reductions. If analyses show that such reductions have occurred, the substitution programs will be halted or reformulated to avoid those impacts.

As part of its Sacramento Valley Conjunctive Use Program, the Department of Water Resources expects to develop a project that will begin to remedy the shortage of reliable information for evaluating surface water and groundwater interaction. The approach is expected to be a combination of the two approaches described above and will probably include a "post audit" evaluation of Drought Water Bank activities in the Butte Basin. The Department has already done a preliminary evaluation of impacts of groundwater production on flows in the Sacramento River for an area in Yolo County. That investigation included installing a monitoring well network, conducting an aquifer performance test to establish aquifer properties, and developing a groundwater model to evaluate reductions in surface water flow from local groundwater extraction.

Wetlands

Potential wetland impacts associated with the Supplemental Water Purchase Program could result if the program creates an incentive for water districts or farmers to reduce the amount of surface water they divert or apply to allow them to sell water to the program. In cases where water district or farming operations are modified to reduce water use, there could be two corresponding wetland impacts:

- Reduced agricultural drainage water for instream and downstream uses and
- Delayed fall flooding.

Many public and private wetland areas in the Central Valley historically have depended on drainage water from upstream agricultural lands for all or part of their water supply. Many of these wetland areas, operated as private and public duck hunting areas, are not guaranteed any specified amount of drainage water; therefore, a reduction or elimination of this drainage water could have a significant impact on wetlands and wildlife utilizing wetland areas. To avoid these types of impacts to wetlands, the program will not purchase water from sellers that provide water by implementing water conservation measures such as tailwater recovery or improved irrigation scheduling. Although water conservation measures are being adopted on many agricultural lands for a variety of reasons, to the extent these measures are already required, such as by the Central Valley Project Improvement Act, then less of the impacts resulting from improved efficiency will be attributed to this program. Historically, the Drought Water Banks did not purchase water developed via tailwater recovery or improved irrigation scheduling because of the difficulty in trying to determine real amounts of water recovered and because of the potential harm to downstream users.

Contractual language that specifically identifies where the water being transferred is coming from will avoid impacts to wetlands and wildlife using these areas.

A delay in fall flooding of agricultural lands could also impact wetlands. In the Sacramento Valley and the Delta, growers are adopting fall and winter flooding programs for both agricultural and wildlife benefits. In the Delta, farmers are flooding corn and wheat fields because of the possibility of reduced subsidence and the benefits for migratory waterfowl and other aquatic birds such as sandhill cranes. The waste grain and invertebrates provide an important wildlife food source.

In the Sacramento Valley, ricelands are also increasingly serving a dual purpose. Rice growers are increasing the fall flooding of their fields to decompose the rice stubble and to provide wildlife habitat for migratory birds. State law[12] requires a phased reduction of rice stubble burning, which has been the primary method of rice straw removal. Rice growers are looking at alternatives to burning, including flooding. Participation by a water district or farmer in a water transfer program could delay the fall flooding programs if the water sold was provided by a reduction in water use.

Wetland impacts could be prevented or minimized by structuring transfer contracts to reduce or eliminate incentives for water districts and farmers to modify normal agricultural practices to reduce water diversions. For example, contracts could provide that water be sold to the program from water generated from groundwater substitution rather than solely reduced water diversions.

To avoid delays in fall flooding, the term of the water contract could be written to end in August or September, before the fall flooding program and before the arrival of most of the migratory birds. In 1994, the term of one groundwater substitution contract ended September 30 to avoid potential conflicts with local duck clubs and their ability to operate fall flooding programs.

This potential significant impact is not expected to occur as a result of the Supplemental Water Purchase Program if the avoidance and minimization measures described above are included in the water purchase contracts.

Wildlife

Adverse impacts to wildlife associated with the Supplemental Water Purchase Program could occur in the event of major fluctuations in water levels of reservoirs, streams, or wetlands. The principal types of wildlife that would be impacted include water-dependent species such as shorebirds, waterfowl, and aquatic- or riparian-dwelling birds, mammals, reptiles, and amphibians. If there were to be drastic changes in water levels associated with this program, particularly during important seasons such as spring reproduction for many riparian species, there could be reductions in populations for one or more consecutive years.

However, the Supplemental Water Purchase Program is not likely to cause widespread losses of water availability in lakes or declines in streamflow in winter and spring in most years. Although summer/fall levels of some lakes could be lower than normal during the year of a transfer, because of differences in water transfer contracts and

12 Health and Safety Code, Section 41865.

refill criteria, it is unlikely that all reservoirs in a particular region would be reduced drastically at the same time. Thus, the program will result in relatively minor flow increases during summer in major rivers used for transfers.

Changes in lake drawdowns due to the Supplemental Water Purchase Program are projected to be within the same range as those caused by typical annual variations in water years. Since refill criteria will be specified in contracts, excessive drawdowns will not occur in consecutive dry years because water transfers will be curtailed until supplies are replenished. Thus, while there is some potential for greater-than-normal lake drawdowns in one year that might last a few consecutive years in the event of a prolonged drought, this would not be a permanent situation. Moreover, this situation would not likely affect all neighboring reservoirs to the same degree. If drawdowns do occur in some reservoirs during summer and fall, most waterfowl and shorebirds could easily adjust by moving down with the water and would not be adversely impacted. No other types of wildlife populations would be potentially impacted by reservoir drawdowns.

Central Valley streams used to transport water during July through October will experience moderately increased flows at that time. It is expected that flows in fall, winter, and spring will be basically normal. Rivers are less likely to be adversely impacted by consecutive dry years than reservoirs that have contracted to supply water, because rivers are often fed by more than one tributary and reservoir. Therefore, overall significant adverse impacts to riparian wildlife are not likely, because they will adjust their use of habitat to the minor increases in summertime water levels and because major losses of flows for consecutive years due to the program are unlikely to be widespread throughout watersheds.

Impacts to wildlife using Central Valley wetlands in refuges or other areas are unlikely to be significant overall. Wetlands supplied by agricultural runoff in supplying regions, for example, will probably not be reduced overall because about the same amount of water will continue to be applied to grow the same or similar crops. Only the source of the water applied will change in areas participating in groundwater substitutions. The amount, quality, or seasons of application will remain the same. Therefore, widespread, perennial regional losses of wetlands and associated wildlife due to the Supplemental Water Purchase Program are also unlikely.

Fish

Effects of Supplemental Water Purchase Program transfers on fish can occur in the streams conveying the water to the Delta and in the Delta itself. In the streams, effects can be due to flow changes resulting from the transfers. In the case of transfers from reservoir releases, changes in the reservoirs or changes in storage may affect releases the following spring. Concerns in the streams focus on salmonids. Poorly-timed releases have the potential to dewater redds of salmonids that spawn in stream margins inundated by high flows that occur during the transfers.

Rivers and Streams

Following is an analysis of potential impacts to rivers and streams that could be impacted from surface water and groundwater substitution transfers resulting from the proposed Supplemental Water Purchase Program. The analysis focuses on streams located on or below reservoirs identified earlier that could be involved in transfers.

Yuba River

Yuba River flow below New Bullards Bar Dam is governed by a 1965 agreement between Yuba County Water Agency and the Department of Fish and Game. The agreement requires minimum flows at various points within the drainage for maintenance of fish, with controls aimed at minimizing wildly fluctuating streamflows. However, the effectiveness of the 1965 agreement in providing flows and water temperature regimes adequate to maintain viable populations of anadromous fish such as chinook salmon, steelhead, and shad has been questioned in recent years. In 1987, several sport-fishing and environmental groups filed a joint complaint with the State Water Resources Control Board claiming that Yuba County Water Agency's reservoir operations were causing adverse impacts on fish in violation of the public trust doctrine. The State Board began investigating the issue, and soon afterward, the Department of Fish and Game began a study to better identify relationships between fisheries and reservoir operations.[13]

The resulting *Lower Yuba River Fisheries Management Plan* recommended increased flows to improve temperatures and optimize habitat for chinook salmon. The State Board reviewed the results of that study and information from a variety of other sources and, in mid-1992, held a series of public hearings about the condition of lower Yuba River fisheries. After considering all the information, the State Board staff prepared a draft analysis to be reviewed by board members in mid-1994. Review of the draft analysis is still in progress, and there is no proposed schedule for further action. Also, in February 1993, the Federal Energy Regulatory Commission, in issuing a new license for Pacific Gas and Electric Company's Narrows Project, changed the flow requirements to help meet the Department of Fish and Game's recommended flows.

Since Yuba River water would likely be transferred during the summer, fish in the lower basin would likely benefit from the increased flows and cooler water.

The Drought Water Bank Environmental Impact Report[14] provides a more detailed description of Yuba River instream flow needs and the effects of the 1991 and 1992 Drought Water Banks on Yuba River flows. In summary, these two transfers induced flow changes that were negligible or only slightly positive. Although flows were still below Department of Fish and Game recommendations for optimum habitat conditions, they were higher than they would have been without a transfer for the Water Bank. Water transfers under the proposed Supplemental Water Purchase Program would be expected to have a similar, slightly beneficial effect on flows in the Yuba

13 Department of Fish and Game. 1991. *Lower Yuba River Fisheries Management Plan*. Stream Evaluation Report 91-1.
14 Department of Water Resources. 1993. *State Drought Water Bank*. Program Environmental Impact Report. Sacramento. 210 pages plus appendixes.

River below New Bullards Bar Dam and, therefore, no significant adverse impacts on fish or other aquatic resources are expected.

Water temperature is critical to all life stages of fish, including the salmonids and American shad in the Yuba River system. In the lower Yuba, water temperature is apparently a major influence on adult fall-run chinook salmon migration.[15] Releasing transfer water too early can trigger adults to begin spawning, only to have the redds stranded or dewatered when flows are reduced after the transfer. Also, if the release of cooler water for the transfer causes warmer water to be released after spawning, it could severely impact the incubating eggs.

Water temperature patterns in the Yuba River are the result of many factors in addition to the temperature of water released from New Bullards Bar and Engelbright Dams. Some factors are solar heating or cooling in transit to the confluence with the Feather River, transit time, and diversion rates.[16] Although several of these factors cannot be controlled, the Department of Fish and Game believes temperature impacts on fish during the fall can be minimized with careful consideration of timing and duration of releases for water transfers.[17]

The Department of Fish and Game recommends that the bulk of water transfers down the Yuba River under the proposed Supplemental Water Purchase Program be completed by September 15. After that, transfers could continue without impact if the sum of the transfer plus any existing instream flow requirement equal the flow required for spawning and rearing through the fall and winter. For example, under the 1965 Agreement, the required flow below Daguerre Point Dam for July 1 to September 30 is 70 cubic feet per second. This requirement increases to 400 cfs from October 1 to December 31. Transfers from the Yuba system could be used to make up the 330 cfs difference.

Figures 17, 18, and 19 show Yuba River flows downstream of the New Bullards Bar Reservoir for critical, dry, and below-normal water years. The bulk of the flows are shown occurring before September 15, as recommended by the Department of Fish and Game. These figures show a slight increase in Yuba River flow with the proposed release from New Bullards Bar Reservoir in each of those year types. Water transfers from the Yuba River system under this program are not expected to affect any of the conditions of the Department of Fish and Game agreement, the Federal Energy Regulatory Commission license, or the expected State Water Resources Control Board instream flow requirements.

Figures 20, 21, and 22 show flow in the Yuba River below Daguerre Point with and without the project. The graphs represent both stored surface water releases and proposed groundwater substitutions from the Yuba County area. Again, the bulk of increased flows occur before September 15 to accommodate the Department of Fish and Game recommendations.

The Department of Water Resources will work with Yuba County Water Agency and the Department of Fish and Game to avoid adverse impacts to spawning fish or redds. Further, Water Resources will consult with Fish and Game to determine if there might

15 Department of Fish and Game 1991. *Lower Yuba River Fisheries Management Plan.* Stream Evaluation Report 91-1.
16 Department of Fish and Game 1991. *Lower Yuba River Fisheries Management Plan.* Stream Evaluation Report 91-1.
17 Dick Daniel, Department of Fish and Game, personal communication. 1995.

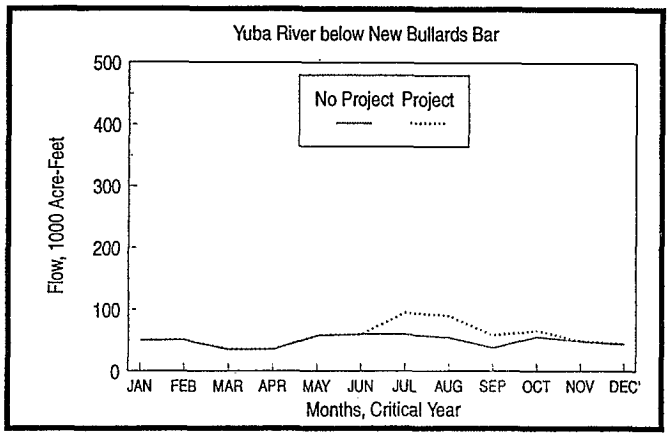

Figure 17
YUBA RIVER FLOW BELOW NEW BULLARDS BAR RESERVOIR, WITH AND WITHOUT THE PROPOSED PROJECT, CRITICAL YEAR

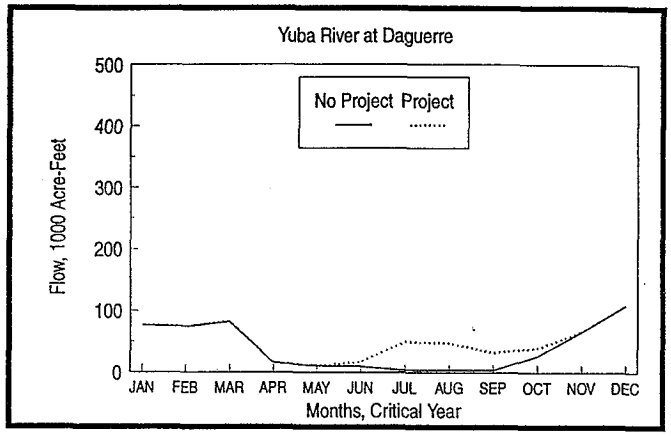

Figure 20
YUBA RIVER FLOW BELOW DAGUERRE POINT DAM, WITH AND WITHOUT THE PROPOSED PROJECT, CRITICAL YEAR

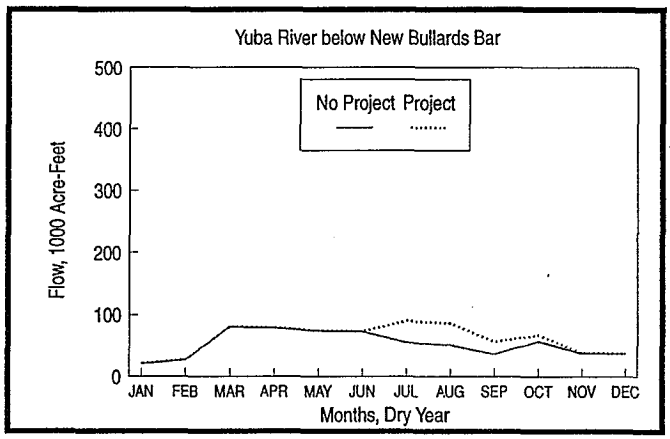

Figure 18
YUBA RIVER FLOW BELOW NEW BULLARDS BAR RESERVOIR, WITH AND WITHOUT THE PROPOSED PROJECT, DRY YEAR

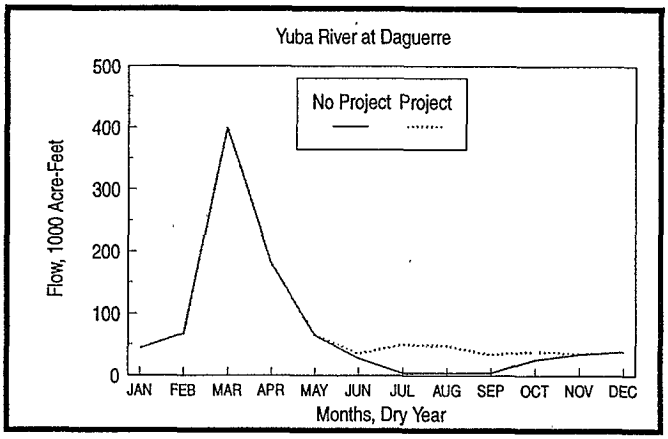

Figure 21
YUBA RIVER FLOW BELOW DAGUERRE POINT DAM, WITH AND WITHOUT THE PROPOSED PROJECT, DRY YEAR

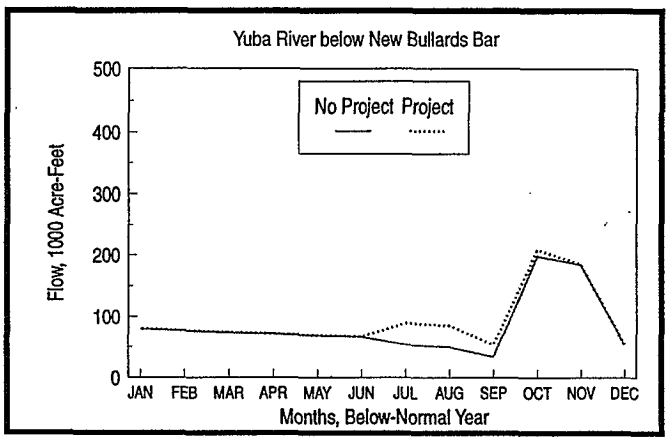

Figure 19
YUBA RIVER FLOW BELOW NEW BULLARDS BAR RESERVOIR, WITH AND WITHOUT THE PROPOSED PROJECT, BELOW-NORMAL YEAR

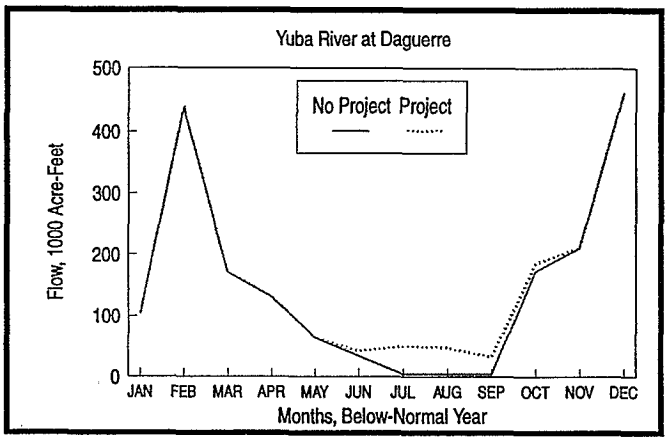

Figure 22
YUBA RIVER FLOW BELOW DAGUERRE POINT DAM, WITH AND WITHOUT THE PROPOSED PROJECT, BELOW-NORMAL YEAR

be an opportunity for a transfer that would, in fact, be beneficial to aquatic resources. Therefore, water transfers from Yuba County Water Agency under the proposed program are not likely to result in significant impacts to the Yuba River system.

Additional concerns regarding transfers, depending on the time when water is actually released and the volume and duration of increased flows, involve the ability of the flows to attract migrating anadromous fish into systems away from home streams, straying into systems that cannot support spawning activity. In 1991, excess water releases by Browns Valley Irrigation District in the system attracted adult salmon into Dry Creek, a tributary to the Yuba River.[18]

To avoid or minimize impacts to fish, the Department of Fish and Game recommends:

- Releases from Browns Valley Irrigation District's Collins Lake generally be of low volume and longer duration to minimize attraction flows.
- The preferred timing of releases be July 1 to August 15.

If flow releases must take place later, it may be necessary to investigate installation of some type of barrier at the mouth of Dry Creek to keep adult fish from entering the stream systems.

Feather River

Prior to previous transfers from the Oroville-Wyandotte Irrigation District, concerns were raised over impacts to resident fish below Sly Creek and Little Grass Valley reservoirs. Jones and Stokes[19] addressed these and other issues and found that a transfer in the range of 10,000 acre-feet would not unreasonably impact the aquatic resources of the system. Likely transfers under the proposed Supplemental Water Purchase Program will be in a similar range and, therefore, no significant impacts are expected as a result of water transfers in this part of the Feather River system.

For Concow Reservoir, the Department of Fish and Game requires Thermalito Irrigation District to maintain a minimum reservoir pool of 1,000 acre-feet and a minimum release below the reservoir of 2 cubic feet per second all year. Fish and Game has also set a maximum release of 50 cubic feet per second. State Water Resources Control Board Decision 1615 (1990) requires that from April 1 through the first week in September (the bass spawning and hatching period), the reservoir level cannot be dropped more than 2 feet in any 3-week period. The reservoir contains many game fish, including trout, largemouth bass, and crappie. Recreation is limited to bank fishing. No water contact is allowed because the reservoir is used as a domestic water supply.

Water could be transferred under the Supplemental Water Purchase Program at any time, because the water would enter Lake Oroville and be stored there until needed. As a result of this flexibility, no adverse impacts to the Concow Creek environment would be expected.

Figures 23, 24, and 25 show Feather River flows at Yuba River with and without the proposed project for dry, critical, and below-normal water year types. Flows are increased

18 John Nelson, Department of Fish and Game, personal communication. 1995.
19 Jones and Stokes Associates. 1990. *Delta Wetlands Project.* Sacramento.

during the July-October transfer period as a result of both stored surface water and groundwater substitution. In all three year types, flow would increase slightly during summer. This could improve streamflow conditions for aquatic resources.

American River

The Department of Fish and Game requires a combined minimum storage of 15,000 acre-feet to meet minimum fish flows downstream in the Rubicon River and Middle Fork American River. Figures 26, 27, and 28 show American River-Folsom inflow for critical, dry, and below-normal years with and without a proposed transfer of 10,000 acre-feet. As depicted in the graphs, only a slight increase in streamflow is expected.

Figures 29, 30, and 31 show expected flows below Nimbus Dam as a result of a 10,000 acre-foot transfer stored in Folsom until mid-October. As shown, increased flows in all year types would occur with the proposed Supplemental Water Purchase Program. This would provide a slight temperature benefit to salmon below Folsom, as well as attraction flows.

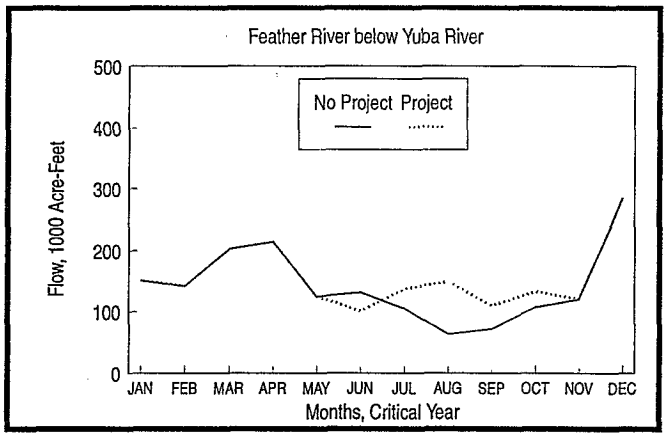

Figure 23
FEATHER RIVER FLOW BELOW YUBA RIVER, WITH AND WITHOUT THE PROPOSED PROJECT, CRITICAL YEAR

Jones and Stokes[20] prepared an environmental analysis of a 1994 transfer of 20,000 acre-feet of water from Placer County Water Agency to the Department of Water Resources. The analysis included an evaluation of potential impacts to fish, wildlife, and recreation relating to the reservoirs and downstream areas. Jones and Stokes concluded that the transfer would not likely result in any unreasonable impacts on fish, wildlife, or other beneficial uses in Folsom Lake and upstream in the American River watershed. For this particular transfer, the Department of Fish and Game requested that water

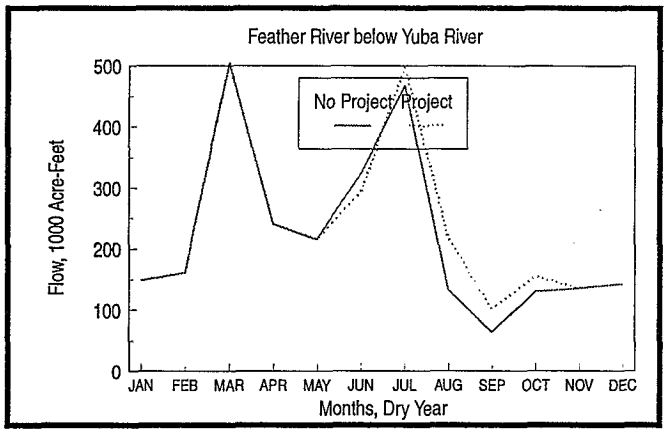

Figure 24
FEATHER RIVER FLOW BELOW YUBA RIVER, WITH AND WITHOUT THE PROPOSED PROJECT, DRY YEAR

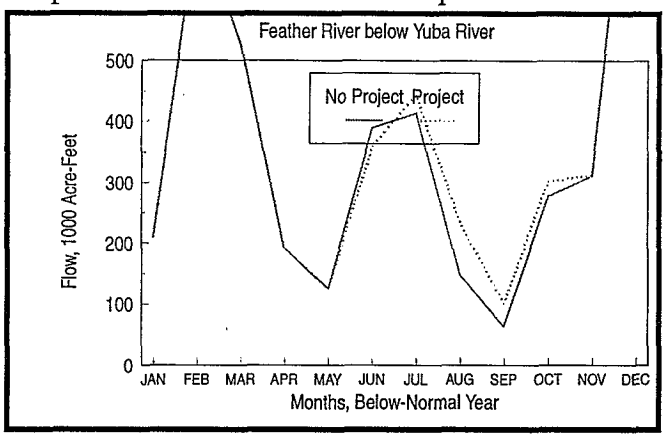

Figure 25
FEATHER RIVER FLOW BELOW YUBA RIVER, WITH AND WITHOUT THE PROPOSED PROJECT, BELOW-NORMAL YEAR

20 Jones and Stokes Associates. 1994. *Environmental Assessment of Impacts from the Proposed Temporary Transfer of Water from Placer County Water Agency to California Department of Water Resources' 1994 Drought Water Bank.* Sacramento.

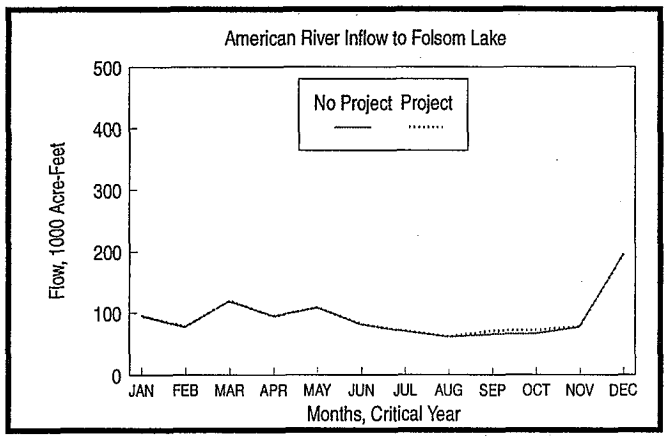

Figure 26
AMERICAN RIVER INFLOW TO FOLSOM RESERVOIR, WITH AND WITHOUT THE PROPOSED PROJECT, CRITICAL YEAR

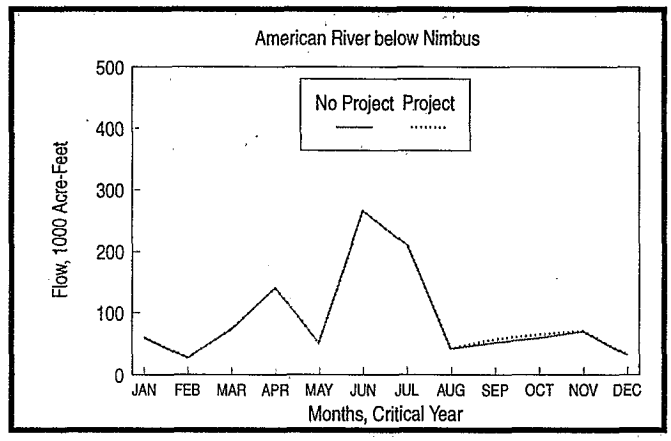

Figure 29
AMERICAN RIVER FLOW BELOW NIMBUS DAM, WITH AND WITHOUT THE PROPOSED PROJECT, CRITICAL YEAR

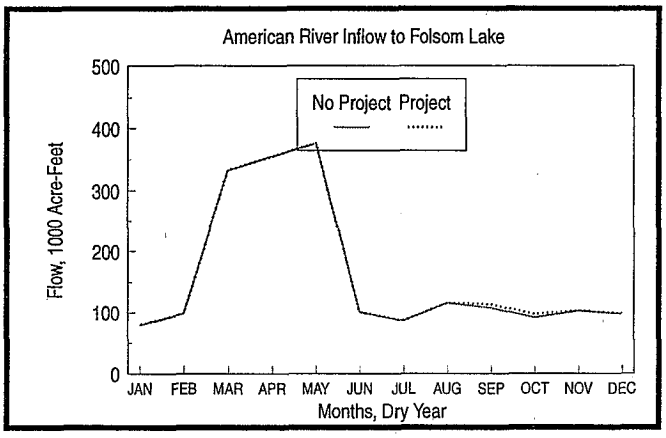

Figure 27
AMERICAN RIVER INFLOW TO FOLSOM RESERVOIR, WITH AND WITHOUT THE PROPOSED PROJECT, DRY YEAR

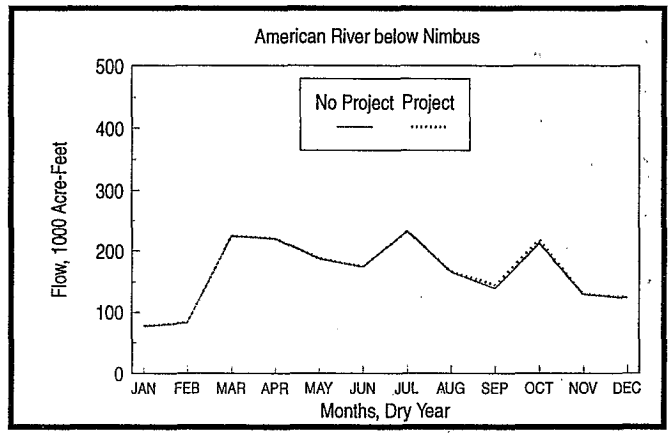

Figure 30
AMERICAN RIVER FLOW BELOW NIMBUS DAM, WITH AND WITHOUT THE PROPOSED PROJECT, DRY YEAR

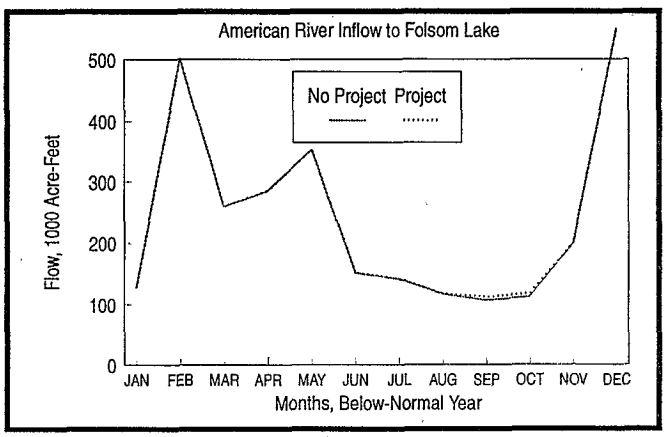

Figure 28
AMERICAN RIVER INFLOW TO FOLSOM RESERVOIR, WITH AND WITHOUT THE PROPOSED PROJECT, BELOW-NORMAL YEAR

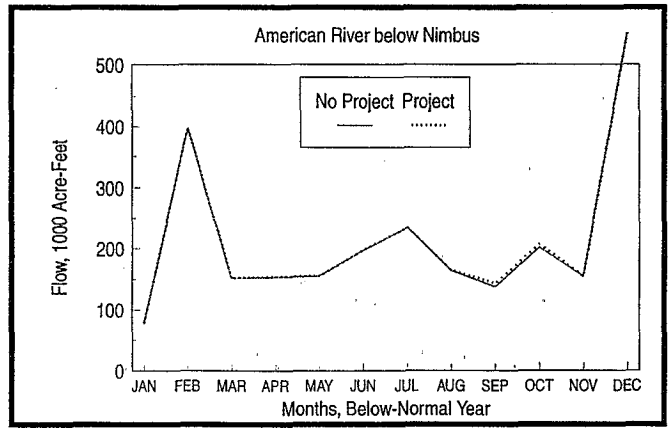

Figure 31
AMERICAN RIVER FLOW BELOW NIMBUS DAM, WITH AND WITHOUT THE PROPOSED PROJECT, BELOW-NORMAL YEAR

released from Hell Hole and French Meadows reservoirs be stored in Folsom Lake as long as possible and released later in the fall to benefit fall-run chinook salmon spawners in the American River below Folsom. The Department of Water Resources accommodated this request by "backing" water into Oroville, allowing the transferred water to stay in Folsom longer and leaving more water available for later release to benefit fall-run chinook salmon. This transfer had no known significant environmental impacts.

Under the proposed program, water transfers with Placer County Water Agency will likely be operated in a manner similar to the 1994 transfer to prevent adverse impacts on fish. Therefore no adverse impacts are expected with regard to transfers from Placer County Water Agency.

San Joaquin River and Tributaries

In the San Joaquin Valley today, there are fall runs of chinook salmon on the three tributary rivers: Merced, Tuolumne, and Stanislaus. Populations of San Joaquin fall run chinook salmon have dwindled to critical levels as a result of a number of factors.[21] Low flows in the tributaries result in less than optimum habitat for most life stages of salmon. Problems include increased water temperature, poor survival in the Delta for spring outmigrants, nuisance aquatic plants, and low dissolved oxygen levels that impede adult escapement. Well coordinated water transfers from the San Joaquin Basin could significantly improve these conditions in the tributaries and the San Joaquin River. For example, Figures 32, 33, and 34 show flows expected at Vernalis as a result of combined transfers from the Merced, Tuolumne, and Stanislaus rivers. These combined fall transfers would result in increased flows at Vernalis well above what might be expected without them during critical, dry, and below-normal years. The increased flows may provide a benefit to adult salmon returning to the San Joaquin River, as well as other aquatic species.

Low flows below Crocker-Huffman Dam on the Merced River have contributed to less than optimum temperature, spawning habitat, and water quality for fall-run chinook salmon. Transfers under the proposed program would be timed such that Merced River instream flows would benefit chinook salmon and other aquatic life.

Merced Irrigation District sold 15,000 acre-feet of water to the 1992 Drought Water Bank for the Department of Fish and Game to use on several wildlife refuges on the west side of the San Joaquin Valley. The intent was to move this water to benefit fall-run chinook salmon in October and November. However, after 11,700 acre-feet had been released, the transfer was stopped because winter-run salmon were found at the State Water Project pumps and, therefore, transfer water that had been released could not be exported.

In July 1993, the State Water Resources Control Board approved a temporary transfer of 60,000 acre-feet of Merced Irrigation District water to Westlands Water District. To help the U.S. Bureau of Reclamation meet Delta outflow requirements, Merced Irrigation District transferred 15,000 acre-feet in April and again in May 1994. Due to a lack of pumping capacity by the CVP and SWP, Merced Irrigation District requested an extension from the State Water Resources Control Board to transfer the remaining

21 San Joaquin River Management Program. 1993. *An Action Plan for San Joaquin Fall-Run Chinook Salmon Populations.*

30,000 acre-feet of purchased water. With the extension granted, Merced Irrigation District released 15,000 acre-feet in July and 15,000 acre-feet in October. The October transfer was done on a schedule to augment attraction flows for adult fall-run chinook salmon. According to Jones and Stokes[22], no impacts to fish, wildlife, or recreation were expected to either Lake McClure or the Merced River downstream. No impacts are known to have occurred as a result of these transfers to the Bureau of Reclamation and Westlands Water District.[23]

Under the proposed Supplemental Water Purchase Program, transfers from the Merced River system would provide benefits to aquatic resources as operational constraints would allow. The Department of Water Resources would consult with the Department of Fish and Game to determine timing, release schedule, and other operational criteria to provide as much benefit as possible.

The Department of Fish and Game has recommended that water transfers from the Merced system be coordinated with operations from other San Joaquin Basin rivers. Merced releases in spring or early summer could reduce releases from the Stanislaus River that might be needed later to improve water quality in the Delta. Fall releases could be coordinated to provide pulse flows to attract adult spawners and improve escapement to the system.

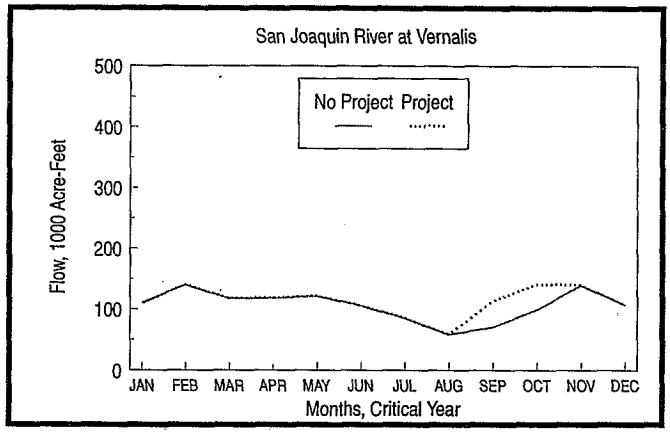

Figure 32
SAN JOAQUIN RIVER FLOWS AT VERNALIS, WITH AND WITHOUT THE PROPOSED PROJECT, CRITICAL YEAR

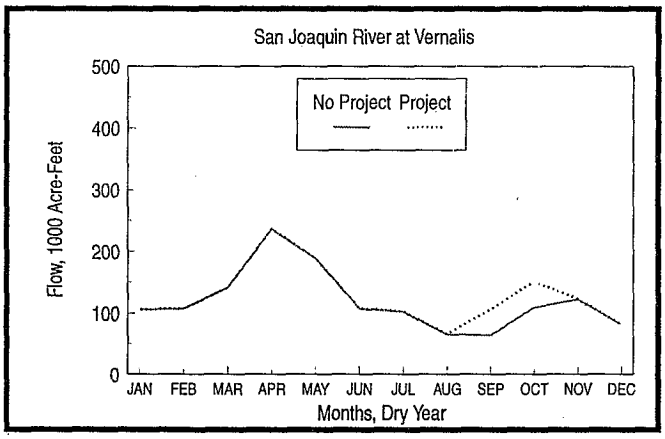

Figure 33
SAN JOAQUIN RIVER FLOWS AT VERNALIS, WITH AND WITHOUT THE PROPOSED PROJECT, DRY YEAR

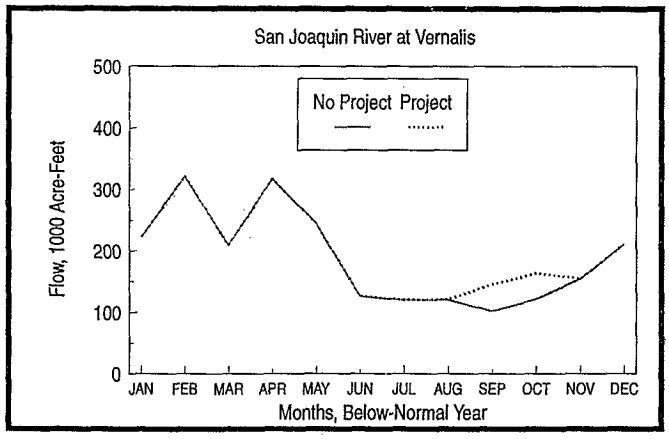

Figure 34
SAN JOAQUIN RIVER FLOWS AT VERNALIS, WITH AND WITHOUT THE PROPOSED PROJECT, BELOW-NORMAL YEAR

22 Jones and Stokes Associates. 1993. *Environmental Impact Assessment for the Proposed Temporary Transfer of Water from Merced Irrigation District to Westlands Water District.*

23 Ted Selb, Merced Irrigation District, personal communication.

Turlock Irrigation District and Modesto Irrigation District are co-licensees of Federal Energy Regulatory Commission license 2299 for New Don Pedro Dam on the Tuolumne River. Under the FERC license, the districts were required to perform 20 years of fish studies in cooperation with the Department of Fish and Game and the U.S. Fish and Wildlife Service. At the end of 20 years, the FERC license was to be reopened for the limited purpose of reassessing the required minimum fish instream flows. Upon agreement of the districts and the intervenors in the reopener proceedings, FERC initiated its first-ever mediation process to resolve the proceedings. The mediation resulted in a settlement agreement that has been signed by all the mediation participants.[24] The new minimum fish instream flows to be provided by the districts (Table 2) and new fish monitoring activities to be paid for by the districts and the City and County of San Francisco are pending before FERC for approval.

The existing minimum instream flow requirements have varied between 40,000 and 123,210 acre-feet per water year. The new requirements will vary from 94,000 to 300,923 acre-feet per water year. Water-year classifications will now be determined using the San Joaquin Basin Index and the Department of Water Resources' April 1 San Joaquin Valley unimpaired runoff forecast.

Traditionally, the existing minimum instream flow schedules have been altered each year upon agreement of the districts and the Department of Fish and Game to accommodate planned fish studies or different spring pulse flow scenarios. The new minimum instream flows are "default" schedules in the event that the districts, Fish and Game, and U.S. Fish and Wildlife Service cannot agree on the fish-flow schedule.

It is uncertain whether the increased instream flows can be transferred at the Delta. Agreement could not be reached on this issue during the mediation, so it was not addressed in the settlement agreement.

Table 2
FLOW SCHEDULE

	Occurrence	October 1 - October 15 (15 days)		Attraction Pulse Flow	October 16 - May 31 (228 days)		Outmigration Pulse Flow	June 1 - September 30 (122 days)		Volume (365 days)
	%	cfs	af	af	cfs	af	af	cfs	af	af
Critical Years and Below	6.4	100	2,975	None	150	57,835	11,091	50	12,099	94,000
Median Critical Year	8.0	100	2,975	None	150	67,035	20,091	50	12,099	103,000
Intermediate Critical Year	6.1	150	4,461	None	150	67,835	32,619	75	10,149	127,507
Median Dry Year	10.8	150	4,463	None	150	67,835	37,060	75	10,149	127,507
Intermediate Dry/Below Normal	9.1	180	5,355	1,676	180	81,402	35,920	75	18,249	142,502
Median Below Normal	10.3	200	5,950	1,736	175	79,146	60,027	75	18,249	165,002
Intermediate Above/Below Normal	15.5	300	8,926	5,950	300	135,669	89,682	250	60,496	300,923
Median Above Normal	5.1	300	8,926	5,950	300	135,669	19,881	250	60,496	300,923
Intermediate Above Normal/Wet	15.4	300	8,926	5,950	300	135,669	89,882	250	60,496	300,923
Median Wet/Maximum	13.3	300	8,926	5,950	300	135,669	89,882	250	60,496	300,923

24 Mediation participants were: Turlock Irrigation District, Modesto Irrigation District, City and County of San Francisco, Department of Fish and Game, U.S. Fish and Wildlife Service, California Sports Fishing Protection Alliance, Friends of the Tuolumne, Tuolumne River Expeditions, Tuolumne River Preservation Trust, FERC staff, and San Francisco Bay Area Water Users Association.

It is unlikely that any additional water would be available for transfer from the districts in drier water years because of the districts' obligation to provide the substantially higher new minimum instream flows and a commitment to the City and County of San Francisco to make a good-faith offer to San Francisco prior to offering water for sale to any out-of-basin entity. However, if stored Tuolumne River water is made available for transfer under the proposed Supplemental Water Purchase Program, any such transfer would be discussed with the Don Pedro Technical Advisory Committee, and an agreed-upon release schedule having maximum instream benefits would be approved by all parties.

New Melones Reservoir water purchased from the U.S. Bureau of Reclamation under the Supplemental Water Purchase Program and released in coordination with the Department of Fish and Game to provide maximum instream benefits such as pulse flows in the spring or fall could benefit instream fisheries in the lower Stanislaus River. Although some benefits to fish could also occur below Vernalis, these would be slight because the water would be exported at the State Water Project. The San Joaquin River Management Plan (1993) recommended using water transfers as a method to improve instream flows in the Stanislaus, benefiting upstream migration of adult salmon.

No significant impacts to the environment are likely to result from release of water for transfers implemented under the Supplemental Water Purchase Program to either the Stanislaus River or the San Joaquin River upstream of Vernalis.

Sacramento-San Joaquin Delta

In the Delta, effects of the transfers on fish can be direct or indirect. Direct effects occur when fish are entrained in water being transferred by the SWP and CVP pumps. Indirect effects may be due to changes in hydrology and flow patterns such as net landward water movement in the lower San Joaquin River (reverse flows). This analysis of Delta impacts focuses on six species: chinook salmon, striped bass, American shad, delta smelt, longfin smelt, and splittail.

Impacts of any water transfer program will be minimized by carrying out the transfers in a manner that does not violate instream flow or Delta fish protective standards or conditions in biological opinions. Reasonable and prudent operational alternatives and incidental take statements in biological opinions pertaining to endangered species influence the period in which water can be transferred without causing unreasonable impacts to the two species now listed, delta smelt and winter-run chinook. Transfers accomplished within existing frameworks for protecting fish in the streams and in the Delta should not have significant adverse environmental impacts.

The general approach to assessing potential impacts of a Supplemental Water Purchase Program is to examine the impacts of three recent water banks — 1991, 1992, and 1994 — which encompass the range of quantity and sources of water that can be reasonably expected in supplemental purchases. Analysis of these transfers can be particularly revealing by looking at direct entrainment impacts of the three water bank transfers. Although it is not possible to accurately predict how many fish might be entrained in future transfers, data from recent transfers can provide an idea of the magnitude of the losses.

Existing Standards and Agreements

Operation of the SWP and CVP is controlled by several agreements, water right decisions, and biological opinions that specify such fish protective measures as streamflow, hydrologic conditions, pumping, and carryover reservoir storage. Operating within conditions of the various agreements provides reasonable protection to a wide variety of fish. The 1995 Water Quality Control Plan for San Francisco Bay and the Delta[25] lists several operating conditions that help determine the period in which water can be transferred from the Delta without unreasonably affecting fish. These protective measures include limitations on the amount of water that can be diverted from the Delta by the SWP and CVP, salinity standards, and closures of the Delta Cross Channel. The federal fish and wildlife agencies have agreed that if the projects operate to these conditions, they will not jeopardize the continued existence of the delta smelt or winter-run chinook salmon. The State Water Resources Control Board staff believes that as long as water transfers through the Delta meet criteria set forth in the Water Quality Control Plan, there will be no unreasonable environmental impacts to fish, wildlife, or other beneficial uses in the Delta.[26]

In the Drought Water Banks, the seasonal vulnerability of winter-run chinook, delta smelt, and splittail to direct entrainment at the SWP and CVP intakes has been the major factor determining when water can be transferred. Since these three species are typically less abundant during summer through early fall, this is the period during which impacts should be minimal. The period available for transfer has been generally July through October, although the 1991 water bank began diversions in May. Under the Water Quality Control Plan, the projects are allowed to pump up to 65% of the inflow during July through October. There are incidental "take" limits during this period as well, but since take is generally low during the summer, the level of take should not adversely affect winter-run chinook or delta smelt nor limit the ability to transfer water during the summer.

Take

The Federal Endangered Species Act defines "take" as including the following:

- ✓ Harass
- ✓ Harm
- ✓ Pursue
- ✓ Hunt
- ✓ Shoot
- ✓ Wound
- ✓ Kill
- ✓ Trap
- ✓ Capture
- ✓ Collect

Take incidental to, and not for the purpose of, carrying out an otherwise lawful activity is "incidental take".

In recent months the spring run of chinook salmon has been added to the list of fish that must be considered when evaluating the impacts of water transfers. Although the California Fish and Game Commission declined to list this race on April 5, 1996, it did stipulate that the Department of Fish and Game monitor the species and will reconsider its listing decision in late 1996. Spring run spawn in late summer/early fall, and the juveniles migrate to the Delta as fry, smolts, or yearlings. Fry and smolts move downstream within the window of protection for winter-run chinook — early winter to late spring. Yearlings from Deer and Mill creeks appear to leave the streams in the early fall, although it isn't clear when they pass through the Delta. Whether the Fish and Game Commission lists it or not, any through-Delta transfers under the Supplemental Water Purchase Program will have to consider potential impacts on this monitored species, and these considerations may affect the transfer window of opportunity.

25 State Water Resources Control Board. 1995. *Water Quality Control Plan for the San Francisco Bay/Delta Estuary.*
26 State Water Resources Control Board. *Water Quality Control Plan Environmental Report.* 1995.

Striped bass salvage is generally low during summer, so the July-October window reduces the chances of unreasonable impacts on this species as well. Juvenile American shad are more abundant in the southern Delta during the summer, and there is the potential for adverse impacts.

The 1995 Water Quality Control Plan contains provisions designed to reduce direct and indirect project impacts on several fish species in the estuary and to improve their habitat. Among these provisions is the requirement for flows during February through June that will maintain the salinity field at about the same locations as during the 1960s and early 1970s. The position of the salinity field, as indexed by the location of the 2-ppt isohaline at the bottom (X_2), will be tied to water year types and will be farther westward for longer periods during the wetter years. The abundance of several fish and invertebrate species has been positively correlated with flow and X_2 position, although other factors also control population abundance. In addition, the Water Quality Control Plan includes additional closures of the Delta Cross Channel to improve survival of chinook salmon juveniles and limits the percentage of inflow that can be diverted. These limits vary from 35% to 65%, depending on the month.

A 1986 agreement[27] (called the Four Pumps Agreement) between the Department of Water Resources and Department of Fish and Game requires the annual losses of certain species of fish at Banks Pumping Plant to be offset. It also provided an additional $15 million one-time payment to improve Delta fisheries affected by the pumping plant.

Information from Drought Water Bank Transfers

Information obtained from the 1991, 1992, and 1994 Drought Water Bank transfers generally applies to future water transfers under the proposed Supplemental Water Purchase Program in that similar amounts of water from the same sources could be transferred during the summer.

In the Delta, effects on fish can be divided into entrainment losses, changes in calculated Delta outflow, and changes in internal Delta flows with emphasis on calculated net flows in the lower San Joaquin River (reverse flow or Qwest). Because calculated net Delta outflows during previous water banks were slightly higher than without, changes in internal Delta flows related to Banks Pumping Plant and the water banks are minor; this impact analysis has, therefore, focused on entrainment impacts. The 1995 Water Quality Control Plan does not have reverse flow or Qwest as a required standard, nor do the new biological opinions for winter-run chinook or delta smelt contain specific reference to Qwest. Reverse flow limitations were key components of the 1993 winter chinook biological opinion.

Direct Entrainment Impacts

Loss of fish at the SWP and CVP facilities in the Delta occur because of predation near the intake, fish screen losses, and handling and trucking losses. For striped bass, chinook salmon, and steelhead, enough data have been obtained to assign numerical

27 Department of Water Resources and Department of Fish and Game. 1986. *Agreement between Department of Water Resources and Department of Fish and Game to Offset Direct Losses in Relation to the Harvey O. Banks Delta Pumping Plant.*

estimates to each of the loss factors, and the numbers lost can be calculated from the salvage. For example, for a prescreening predation rate of 75%, a screen efficiency of 85%, and a handling and trucking loss of 1%, one thousand chinook salmon salvaged at Skinner Fish Facility would result in a calculated loss of 3,716 salmon (for every salmon salvaged, an additional 3.7 salmon were calculated to have been lost before or after the salvage).

For splittail, delta smelt, American shad, and longfin smelt, there are no estimates of prescreening loss, screen efficiency, or handling and trucking losses, so changes in salvage are used to evaluate effects of water transfers.

The amount of transfer water exported from the Delta in the three previous water banks has ranged from about 159,000 acre-feet in 1992 to about 400,000 acre-feet in 1991 (Table 3). Supplemental Water Purchase Program transfers are expected to fall in this range as well. Although some water was transferred in April to June and in November, by far the bulk of the water moved out of the Delta in July through October. In the 1991 Drought Water Bank, only the SWP pumps were used to move the water; in 1992 and 1994, both SWP and CVP facilities were used to minimize fish losses; in future drought water banks, both facilities will likely be used when operationally possible. Note that the values shown in Table 3 are for Water Bank transfers only; the pumps were also moving project entitlement water at the same time.

The 1991 Drought Water Bank included large numbers of water purchases from Delta landowners who agreed not to divert specified amounts of water from Delta channels for irrigation (fallowing). The 1992 and 1994 Water Banks only included sales from upstream areas, where in most cases the sellers agreed to forego their surface water supplies, such as from the Feather River, and obtained water for their own use from groundwater. About half of the Supplemental Water Purchase Program transfers are

Table 3
DROUGHT WATER BANK EXPORTS FROM THE DELTA IN 1991, 1992, AND 1994
In Acre-Feet per Month

Month	1991* SWP	1992 SWP	1992 CVP	1994 SWP	1994 CVP
April	2,000				
May	6,000				
June	9,000				
July	40,000	0	32,000		
August	80,000	28,000	14,000	70,000	7,000
September	116,000	28,000	11,000	60,000	2,000
October	133,000	13,000	25,000	38,000	1,000
November	14,000	0	4,000	0	0
December		0	4,000	0	0
Total	400,000	60,000	90,000	168,000	10,000
Grand Total		159,000		178,000	

* In 1991, 10,000 acre-feet was retained as carryover storage at State Water Project facilities south of the Delta, and an additional 260,000 acre-feet was retained as carryover storage in Lake Oroville.

expected to be from groundwater substitutions. In the 1991 Water Bank, the fallowing program resulted in less water being diverted directly from Delta channels and, thus, fewer fish entrained in local, unscreened diversions.

Estimated salvage and loss of six key fish species for the 1991, 1992, and 1994 Drought Water Banks are shown in Tables 4, 5, and 6. Although the numbers appear to be precise, they are actually estimates with generally large, but unknown, errors. Salvage estimates are made by counting subsamples of fish at the facilities for short periods every 2 hours and expanding the counts to account for the fraction of total time available for counting. For example if DFG counted fish for 10 minutes every 2 hours, the expansion factor would be 12. If they actually counted 10 fish during all the 2-hour counts, the total daily salvage would be 120 fish. To obtain losses of striped bass and chinook salmon, the salvage numbers are expanded by various loss factors to estimate losses.

The losses of striped bass and chinook salmon have been converted to standard units called "yearling equivalents". The conversion involves using estimated survival from the juvenile stages of a certain size to the equivalent numbers of fish as yearlings.

Table 4
CALCULATED LOSS OR SALVAGE OF SIX FISH SPECIES AT THE STATE WATER PROJECT INTAKE FOR 1991 WITH AND WITHOUT THE WATER BANK

Banks Pumping Plant, With Water Bank

		Loss		Salvage			
Month	Pumping Rate *(cfs)*	Striped Bass	Chinook Salmon	American Shad	Split-tail	Delta Smelt	Longfin Smelt
May	1,280	2,648	17,767	96	278	242	1,222
June	869	57,385	3,656	1,888	10,510	6,238	216
July	729	39,858	0	7,413	2,245	5,339	750
August	2,051	23,756	0	119,348	0	1,164	0
September	2,215	4,491	0	62,145	0	0	517
October	3,388	991	382	44,488	353	381	0
November	1,076	1,621	5,882	15,715	0	0	0
December	1,278	34,260	12	37,108	0	0	0
Total		165,010	27,699	288,201	13,386	13,242	2,705

Banks Pumping Plant, Without Water Bank (Estimated)

		Loss		Salvage			
Month	Pumping Rate *(cfs)*	Striped Bass	Chinook Salmon	American Shad	Split-tail	Delta Smelt	Longfin Smelt
May	1,181	2,439	16,580	88	256	110	1,127
June	718	45,973	3,072	1,559	8,683	5,152	178
July	78	4,093	0	794	240	572	80
August	753	8,653	0	43,821	0	427	0
September	272	492	0	7,639	0	0	63
October	1,228	330	140	16,125	127	138	0
November	828	1,040	4,806	12,104	0	0	0
December	1,278	34,260	12	37,108	0	0	0
Total		97,280	24,610	119,241	9,308	6,400	1,449

Table 5
CALCULATED LOSS OR SALVAGE OF SIX FISH SPECIES AT THE STATE WATER PROJECT AND CENTRAL VALLEY PROJECT INTAKES FOR 1992 WITH AND WITHOUT THE WATER BANK

Banks Pumping Plant, With Water Bank

Month	Pumping Rate (cfs)	Loss		Salvage			
		Striped Bass	Chinook Salmon	American Shad	Split-tail	Delta Smelt	Longfin Smelt
July	419	7,894	0	57,067	0	0	0
August	1,480	2,216	0	59,701	6	0	0
September	2,726	351	10	976	4	0	0
October	742	10	0	85	0	0	0
Total		10,471	10	117,829	10	0	0

Banks Pumping Plant, Without Water Bank *(Estimated)*

Month	Pumping Rate (cfs)	Loss		Salvage			
		Striped Bass	Chinook Salmon	American Shad	Split-tail	Delta Smelt	Longfin Smelt
July	419	7,894	0	57,067	0	0	0
August	1,022	1,530	0	41,226	4	0	0
September	2,252	290	8	691	3	0	0
October	541	7	0	62	0	0	0
Total		9,721	8	99,046	7	0	0

Tracy Pumping Plant, With Water Bank

Month	Pumping Rate (cfs)	Loss		Salvage			
		Striped Bass	Chinook Salmon	American Shad	Split-tail	Delta Smelt	Longfin Smelt
July	897	2,370	0	529	0	0	0
August	989	598	0	166	37	0	0
September	1,594	751	0	706	0	0	0
October	967	1,375	0	253	0	0	0
November	1,278	3,536	0	4,209	0	0	0
Total		8,630	0	5,863	37	0	0

Tracy Pumping Plant, Without Water Bank *(Estimated)*

Month	Pumping Rate (cfs)	Loss		Salvage			
		Striped Bass	Chinook Salmon	American Shad	Split-tail	Delta Smelt	Longfin Smelt
July	372	983	0	219	0	0	0
August	658	398	0	110	25	0	0
September	1,533	722	0	679	0	0	0
October	881	1,253	0	230	0	0	0
November	1,268	3,342	0	3,978	0	0	0
Total		6,698	0	5,216	25	0	0

Table 6
CALCULATED LOSS OR SALVAGE OF SIX FISH SPECIES AT THE STATE WATER PROJECT AND CENTRAL VALLEY PROJECT INTAKES FOR 1994 WITH AND WITHOUT THE WATER BANK

Banks Pumping Plant, With Water Bank

		Loss		Salvage			
Month	Pumping Rate (cfs)	Striped Bass	Chinook Salmon	American Shad	Split-tail	Delta Smelt	Longfin Smelt
August	3,408	2,501	0	2,944	6	0	0
September	3,565	7,611	0	8,732	12	0	0
October	2,590	76	0	640	0	0	0
Total		10,188	0	12,316	18	0	0

Banks Pumping Plant, Without Water Bank *(Estimated)*

		Loss		Salvage			
Month	Pumping Rate (cfs)	Striped Bass	Chinook Salmon	American Shad	Split-tail	Delta Smelt	Longfin Smelt
August	2,274	151	0	1,476	3	0	0
September	2,553	5,678	0	5,276	7	0	0
October	1,877	58	0	397	0	0	0
Total		7,247	0	7,149	10	0	0

Tracy Pumping Plant, With Water Bank

		Loss		Salvage			
Month	Pumping Rate *(cfs)*	Striped Bass	Chinook Salmon	American Shad	Split-tail	Delta Smelt	Longfin Smelt
August	2,435	3,204	0	16,152	0	0	0
September	3,540	3,687	0	11,652	0	0	0
October	2,488	1,574	7	10,872	0	0	0
Total		8,465	7	38,676	0	0	0

Tracy Pumping Plant, Without Water Bank *(Estimated)*

		Loss		Salvage			
Month	Pumping Rate *(cfs)*	Striped Bass	Chinook Salmon	American Shad	Split-tail	Delta Smelt	Longfin Smelt
August	2,373	3,118	0	15,739	0	0	0
September	3,528	3,676	0	11,612	0	0	0
October	2,488	1,573	7	10,872	0	0	0
Total		8,367	7	38,223	0	0	0

In Tables 4-6, the with-water-bank salvage and loss estimates are those that actually occurred during months when the Drought Water Bank was operating. To obtain the without-water-bank estimates, we simply used the proportion of water being pumped for the Water Banks as compared to the total pumping during that period.

Including May, June, and July in the 1991 Drought Water Bank pumping window resulted in comparatively high salvage and loss of all of the six key species except American shad. In the case of chinook salmon, the high salvage during this period is due to the seasonal downstream movement of mostly fall-run smolts through the Delta toward the ocean. During late spring and early summer, splittail, delta smelt, longfin smelt, and striped bass have just completed or are in the middle of their spawning cycle in the Delta and upstream areas and are more vulnerable to entrainment. In the summer, these fish move farther down the estuary, decreasing their chances of being entrained. American shad, on the other hand, spawn upstream in tributaries to the Sacramento River and move into the Delta as juveniles during July, August, and September.

Losses and salvage estimates shown in Table 4 for 1991 overstate the actual impact of the Drought Water Bank on the selected fish species. During this Water Bank, much of the purchased water came from a Delta fallowing program in which farmers agreed not to divert a portion of their normal water supply from adjacent channels. Since these diversions were all unscreened and have been shown to entrain fish,[28] decreased diversions to the islands resulted in less fish being lost to in-Delta agricultural practices. However, it is not yet possible to quantify the net effects of the change in points of diversion on total fish losses.

In 1992 and 1994, shifting the Water Bank pumping window to July through October reduced its impact on listed and sensitive fish (splittail, delta smelt, chinook salmon, and longfin smelt) to essentially zero (Tables 5 and 6) and also reduced the possibility of adverse impacts on striped bass. In all three years, chinook salmon losses, including winter and spring runs, were low in October, indicating that extending Supplemental Water Purchase Program transfers through October should have little impact on either race.

In addition to the direct fish mitigation requirements of the 1986 DWR/DFG agreement[29], the Department of Water Resources provided an additional 300,000 striped bass as a result of the 1991 Drought Water Bank. Mitigation for transfers under the 1992 Drought Water Bank were in the form of a surcharge applied to each acre-foot of water exported (transfer water) to be used by the Department of Fish and Game to offset potential impacts in the Delta, as well as requirements of the 1986 DWR/DFG agreement.

Table 7 summarizes total salvage and loss estimates for the three Drought Water Banks and incremental losses attributable to them. Calculated fish losses associated with the 1991 Water Bank were much greater than the two that followed. The differences are due in part to the size of the Water Banks — more than twice as much water in 1991

28 R.L. Brown. 1982. *Screening Agricultural Diversions in the Sacramento-San Joaquin Delta.* Unpublished manuscript, Department of Water Resources, Sacramento. 40 pp.

29 Department of Water Resources and Department of Fish and Game. 1986. *Agreement between Department of Water Resources and Department of Fish and Game to Offset Direct Losses in Relation to the Harvey O. Banks Delta Pumping Plant.*

than in 1992 and 1994 — but mainly to the fact that the 1991 Water Bank diverted a significant part of its water from the Delta in late spring and early summer. Shifting the beginning of the diversion window into late July in the later years reduced entrainment of the six key fish species.

The information in Table 8 can be used to put the losses and salvage into perspective as compared to the total estimated annual losses and salvage for 1986 to 1993. Again, it appears that a Water Bank diversion window of July through October reduces the losses to such an extent that water transfers during this period should not have a

Table 7
TOTAL LOSSES AND SALVAGE OF SIX FISH SPECIES AND ESTIMATED LOSSES ATTRIBUTABLE TO THE DROUGHT WATER BANKS

1991 Water Bank

	Loss		Salvage			
	Striped Bass	Chinook Salmon	American Shad	Split-tail	Delta Smelt	Longfin Smelt
Total	165,010	27,699	288,201	13,386	13,242	2,705
Attributable to Water Bank	67,730	3,089	168,960	4,078	6,842	1,256

1992 Water Bank

	Loss		Salvage			
	Striped Bass	Chinook Salmon	American Shad	Split-tail	Delta Smelt	Longfin Smelt
Total	19,101	10	123,692	47	0	0
Attributable to Water Bank	2,682	2	19,430	15	0	0

1994 Water Bank

	Loss		Salvage			
	Striped Bass	Chinook Salmon	American Shad	Split-tail	Delta Smelt	Longfin Smelt
Total	18,653	7	50,992	0	0	0
Attributable to Water Bank	3,039	0	5,602	0	0	0

Table 8
ESTIMATED SALVAGE AND LOSS OF SIX FISH SPECIES AT BANKS PUMPING PLANT, 1986-1993

	Loss *(Yearling Equivalents)*		Salvage			
Year	Striped Bass	Chinook Salmon	American Shad	Split-tail	Delta Smelt	Longfin Smelt
1986	544,429	1,973,164	1,139,342	2,391,588	6,380	2,296
1987	683,712	1,636,872	538,843	69,036	61,017	56,847
1988	854,041	1,609,586	420,685	75,016	63,810	164,045
1989	796,240	1,486,018	644,696	60,584	20,074	67,545
1990	790,811	1,349,238	627,401	43,518	34,126	50,565
1991	635,525	709,733	455,804	36,819	17,822	9,665
1992	499,816	510,455	710,154	12,082	6,178	3,590
1993	481,674	297,578	1,156,674	200,217	31,266	648

significant adverse impact on populations of the six fish species examined. For example, the 1991 Water Bank moved some water in June, which resulted in an estimated loss of more than 3,000 chinook salmon smolts (Table 7). This loss was reduced to near zero in 1992 and 1994 by moving the transfer window to later in the summer.

Although concerns about authorized take for delta smelt and winter-run chinook did not arise during the previous water banks, take limitations do provide an additional level of protection for these fish. For chinook salmon, genetic studies being conducted by scientists at the UC-Davis Bodega Marine Laboratory may soon provide a reliable means of distinguishing between the four salmon races salvaged at the Delta pumps. The genetic markers being developed can lead to a non-lethal means of helping ensure that project pumping, including water transfers, does not jeopardize the continued existence of the species.

Avoidance, Minimization, and Mitigation

Significant impacts to Delta fish will be avoided by pumping transferred water during July through October. Although some fish will be lost directly at the pumps as a result of the proposed Supplemental Water Purchase Program, measures such as the 4-Pumps Agreement are already in place to mitigate for direct losses to chinook salmon, steelhead trout, and striped bass. Although unlikely, any additional mitigation measures will depend on actual transfers and will be worked out each year with the Department of Fish and Game and other fish agencies.

The CALFED Operations Group will play a key role in impact avoidance. This group, along with its subteams, uses real-time fish monitoring and other data to assess project impacts and develops necessary recommendations to protect fish and maintain water supplies.

Energy Consumption

The proposed Supplemental Water Purchase Program is expected to result in increased energy consumption, mainly related to increased pumping for water supply and transport. Water suppliers that choose to enter into groundwater substitution contracts will be required to increase pumping over baseline levels for that program, which would result in increased use of energy resources. Also, transfer water transported through the California Aqueduct to State Water contractors in the south and central coast will require some additional electricity for pumping to make deliveries.

Energy Consumption for Groundwater Substitutions

The groundwater substitution program of the Supplemental Water Purchase Program is projected to allow up to 200,000 acre-feet of surface water now allocated for use in supplying regions to be sold to State Water Contractors. This would represent about a 10 percent increase in the total amount of groundwater pumped annually in the Sacramento Valley region, according to DWR estimates. If all pumping for groundwater substitutions used electric power, about 190 million kilowatt hours would be

required, likewise representing about a 10 percent increase in energy use in that area. This amount of power is estimated to cost about $1.65 million to $2.40 million at current rates. Total purchase price of groundwater made available by substitution will likely compensate sellers' costs for the additional energy used for pumping.

It is unlikely that all or even most Supplemental Water Purchase Program groundwater pumping will use electric power. In the past, most Sacramento Valley groundwater pumping for the Drought Water Bank and other short-term water transfers used alternative energy sources. Most Drought Water Bank pumps were diesel-powered, and some others were powered by propane or natural gas. Therefore, it is likely that even with groundwater substitutions occurring at the maximum projected program level (200,000 acre-feet), additional consumption of electric power for groundwater pumping is unlikely to exceed 5 percent of the existing regional annual baseline amount of electricity used for pumping, due to probable use of alternative energy sources.

Energy Consumption for Delta Exports

Supplemental Water Purchase Program water that is exported from the Delta and wheeled to State Water Contractors via the California Aqueduct will use additional energy for pumping. The precise amount of energy that will be used cannot be predicted because the amount of water and delivery destinations are unknown. However, net additional power consumption can be estimated given a number of assumptions about the overall nature of water transfers for the Supplemental Water Purchase Program.

Records of SWP water deliveries and energy consumption from 1986 through 1995 were reviewed to provide baseline information (Table 9). During that time, an average of 2,017,000 acre-feet of entitlement water was delivered annually. On average, the State Water Project used about 5.069 billion kilowatt-hours annually for pumping, recovered 1.388 billion kilowatt-hours from power generation, for a net average

Table 9
ANNUAL ENTITLEMENT WATER DELIVERIES AND ASSOCIATED POWER CONSUMPTION AND GENERATION

Year	Entitlement Deliveries *(thousand acre-feet)*	Energy Consumed *(million kilowatt-hours)*	Energy Generated *(million kilowatt-hours)*	Net Energy Consumed *(million kilowatt-hours)*
1986	1996	4858	1255	3603
1987	2130	4527	1317	3210
1988	2385	5607	1548	4059
1989	2854	7191	1854	5337
1990	2582	7932	2353	5579
1991	549	4237	1175	3062
1992	1471	3996	1165	2831
1993	2315	4242	1014	3228
1994	1862	4636	1319	3316
1995	2029	3470	881	2589
10-Year Average	2017	5070	1388	3682

power consumption of 3.681 billion kilowatt-hours per year. However, there has been considerable variation between years due to hydrologic conditions and pumping restrictions implemented for environmental regulatory requirements.

A model was developed to estimate net incremental power consumption by the Supplemental Water Purchase Program for three water year types: below-normal, dry, and critical. Hydrologic data from 1945, 1949, and 1931 were used to represent these year-types, respectively. It was assumed that a total of 393,000 acre-feet would be purchased, but that about 20 percent less would be pumped from the Delta due to carriage water requirements that would contribute to Delta outflow. To simplify this analysis, it was assumed that water exported from the Delta was delivered about equally to Kern County Water Agency and Metropolitan Water District of Southern California. Given these assumptions, incremental power consumption and generation associated with transferring Supplemental Water Purchase Program water during July through October were calculated.

Annual net energy consumption as a result of the Supplemental Water Purchase Program was calculated at 584 million to 588 million kilowatt hours. These values were remarkably constant regardless of year type, reflecting the direct energy required for pumping minus energy gained from generation, assuming delivery to Kern County Water Agency and Metropolitan Water District of Southern California. This amount of net energy consumption represents an incremental increase of about 16 percent above average annual energy consumption by the State Water Project from 1986 to 1995.

The model predicts that Supplemental Water Purchase Program transfers will consume a substantial amount of energy by transporting the water through the State Water Project. Because pumping would be scheduled in late summer, when regional energy demands for other uses are also high, this impact probably will be greater than it would be at other times of year. Certainly, SWP operations will minimize both costs and impacts by scheduling pumping during off-peak hours as much as possible. Program participants will pay for the wheeling costs regardless, and since this amount of pumping is only about 16 percent more than recent average annual energy usage, projected energy consumption by the proposed project is not considered wasteful nor greater than the range of normal SWP operations.

Because the Supplemental Water Purchase Program is proposed as a short-term (6-year) program that may or may not operate every year, the required energy consumption will be a temporary and probably intermittent increased allocation of resources rather than a permanent commitment.

Although there will be an unavoidable and irretrievable increase in energy use during years when the program operates, the increases from existing amounts of energy consumed annually for water pumping are only projected to range from about 10% for groundwater substitution programs to 16% for the State Water Project. These analyses indicate that energy consumption necessary for the program will be only minor incremental increases above existing amounts of baseline energy used for pumping that will be fully paid for. Consequently, the overall programwide increase in energy consumption is not likely to be a significant environmental impact during the term of the proposed program, especially relative to overall statewide annual energy consumption.

Land Use

Land use in the areas selling water to the Supplemental Water Purchase Program is generally not expected to change significantly as a result of implementation of this program. Under this program, current agricultural activities will continue in those areas where groundwater substitutions might take place. It has been argued that some farmers entering groundwater substitution programs may try to plant a crop that uses less water to save money by pumping less while still being paid for the amount of surface water that is not diverted. To avoid this situation in previous Water Banks, contracts contained language that only allowed the seller to be paid for the lesser amount of groundwater pumped above historical amounts and the undiverted surface water. This language discouraged the possibility that a grower might actually fallow land and collect money from the sale of undiverted surface water. Further, the Department of Water Resources actually monitored the land use of the areas where groundwater substitutions took place to determine if in fact any significant changes occurred from that which was expected. Over the course of the previous Water Banks, which included no fallowing of crops, no significant changes in agricultural practices or cropping patterns occurred as a result of Water Bank activities.

The Department of Water Resources will continue to monitor land and water use as necessary in areas where groundwater is substituted to ensure that no significant changes to normal agricultural practices occur as a result of this program. Therefore, no significant impacts to land use are expected from implementation of this program in those supplying regions.

Water transferred under this program will be going to agricultural, municipal, and industrial uses within the service area of the State Water Project. The water will be used for the same purposes as existing water supplies, and will only make up for entitlement deficiencies in only the 6 years of this program. Therefore, no significant changes in land use are expected as a result of receiving augmented water supplies under this program.

San Joaquin Valley Subsurface Drainage

In some areas of the San Joaquin Valley, high water tables result in subsurface agricultural drainage problems. The inability of these lands to adequately drain or percolate irrigated water has resulted in thousands of acres with a rising salinity problem and a high volume of drainage water high in salts and trace elements such as selenium. The San Joaquin Valley Drainage Program Management Plan identifies measures to reduce many of the problems related to the subsurface drainage problem.

Poor agricultural production due to drainage problems has resulted in some land going out of production. Also, impacts to waterfowl and shorebirds have resulted because some of this drainage water has been stored in evaporation ponds. Although recent efforts are minimizing and avoiding impacts to wildlife, some areas are still experiencing problems.

Water transfers under the proposed Supplemental Water Purchase Program could provide some of these drainage-prone areas with supplemental water. Although some areas in Tulare and Kern counties will receive this water, no new land will be put into production, thereby preventing the existing problem from becoming worse.

Also, in Tulare County, where some groundwater is available for local agricultural use, transfers from this program may, in fact, keep the drainage problem from becoming worse by allowing exported (transferred) water to become available in place of the poorer quality groundwater. Although this land will still be contributing subsurface drainage water, exported water is considerably better quality than the local groundwater, which often contains high concentrations of selenium.

In Kern County, where land has gone out of production as a result of drainage problems, the proposed Supplemental Water Purchase Program is not likely to allow for the land to return to production, primarily based on cost. Landowners would have to pay normal full cost of entitlement water plus the additional price of the supplemental water. These collective costs would be prohibitive to landowners; hence it is unlikely this land will contribute to subsurface drainage problems.

No new land will be put into production, thus eliminating the need for additional drainage facilities, including evaporation ponds. Therefore, no significant impacts to agricultural land are expected from the proposed program.

Recreation

Recreation in streams that may be affected by the proposed Supplemental Water Purchase Program could likely benefit from the program. In most cases, streamflow will be increased over normal conditions and rafters, boaters, and others may actually benefit.

Recreation in the Delta should not be impacted. Although additional flows will occur there, it is unlikely to be felt compared to the large volume of water that would normally exist.

Recreation losses in the reservoirs could be significant when releases are made early in the recreation season, in which case normal operational problems would also occur earlier and last through much of the recreation season. This would especially affect the smaller reservoirs due to low lake levels throughout the recreation season.

In most cases, recreational impacts as a result of this project are expected to be minor, occurring only for a short time and only in some years. Most impacts would be similar to those in dry years when reservoirs are drawn down as the summer progresses.

Yuba River

Recreational opportunities at New Bullards Bar Reservoir include camping, picnicking, boating, fishing, and swimming. Two boat ramps at the reservoir are open year round. Boating access has not been impacted as a result of water transfers from the reservoir. No impacts to recreation at New Bullards Bar Reservoir are expected to occur from the proposed Supplemental Water Purchase Program.

Recreation at Collins Lake (operated by Browns Valley Irrigation District) includes swimming, boating, fishing, camping, and picnicking. Facilities are operated by a concessionaire and are open year-round. Peak use is generally mid-March through Labor Day weekend. The one launch ramp at the lake reaches to elevation 1,132 feet, but the concessionaire does have temporary ramp facilities that have been used when lake levels are lower. Lower lake levels are expected as the season progresses, and recreational use is generally tied to the water level.

During previous Drought Water Banks, transfers occurred during September and October, generally after the peak recreation season, with no significant impacts to recreation at Collins Lake. Under the proposed Supplemental Water Purchase Program, if transfers are conducted between June 1 and August 15 to avoid providing attraction flows to salmon, then water levels in the reservoir would be lower at an earlier date, possibly resulting in significant impacts to recreation at the reservoir. Water released in June would be "backed" into Oroville for later release.

The Department of Water Resources will coordinate closely with Browns Valley Irrigation District to identify a period for transfer that will minimize or avoid recreational impacts associated with water level reduction. Close coordination with the Department of Fish and Game may identify a period where neither fish nor recreational impacts will occur. It may be necessary to install a fish barrier at the mouth of Dry Creek to avoid salmon impacts and still maintain viable recreation at this reservoir.

Feather River

In the Oroville-Wyandotte Irrigation District system, both Sly Creek and Little Grass Valley reservoirs support outdoor recreation including camping, boating, and fishing.

Under agreement with the U.S. Forest Service, recreation facilities at Sly Creek Reservoir are open July 1 to September 30. Transfers from Sly Creek Reservoir for the Drought Water Banks have not resulted in adverse impacts to recreation. Therefore, transfers of the same magnitude, expected under the proposed program, would not likely cause any significant adverse environmental impacts to recreation at Sly Creek Reservoir.

Facilities at Little Grass Valley Reservoir were constructed using funds from the Davis-Grunsky program. Under the Davis-Grunsky agreement, the recreational facilities must be open and operational from May 15 to September 30. Water transfers from the Drought Water Banks have resulted in lower water levels late in the season, making boat launching more difficult than in years with higher water levels. Homeowners around the lake filed complaints with the State Water Resources Control Board, but Oroville-Wyandotte personnel successfully demonstrated that boat access is still available and that no unreasonable impacts to recreation at this facility occurred as a result of these transfers.[30] Transfers under the proposed program similar to those of previous transfers in this system would not likely result in significant impacts to recreation at Little Grass Valley Reservoir.

30 Steve Onkin, Oroville-Wyandotte Irrigation District, personal communication.

American River

Recreation at Hell Hole and French Meadows reservoirs includes camping, swimming, boating, fishing, and picnicking. The facilities are open year-round, but peak use is generally in May through September. As a result of normal operations, the levels of both reservoirs generally drop as the season progresses. In 1991, the lakes reached their historical lows: 40,000 acre-feet in Hell Hole and 29,000 acre-feet in French Meadows. Normal operations allow for a combined storage of 140,000 acre-feet, with 90,000 acre-feet in Hell Hole and 50,000 acre-feet in French Meadows. Normal operation usually results in lake levels that render the boat ramps unusable in August or September. Although recreation is impacted, the lake and shoreline facilities are still available to the public.

Water transfers from Placer County Water Agency under the proposed program are likely to be in the range of 10,000 acre-feet. If the water is released later in September or October, impacts to recreation should not be unreasonable. However, if water is released earlier, then lake levels could be reduced earlier and result in a potentially significant impact to recreation at these two reservoirs. This water would also flow through Folsom Lake but would not likely have any significant adverse impacts to summer recreation there. In fact, the water transfer might actually be beneficial from a recreational perspective. More water in Folsom Lake later in summer could keep water levels there slightly higher, thus reducing impacts to boaters, swimmers, and others.

To minimize and avoid recreational impacts to Hell Hole and French Meadows reservoirs, the Department of Water Resources will coordinate with the U.S. Bureau of Reclamation and Placer County Water Agency to move transferred water at a time that would have the least impact regarding water level reductions, avoiding reductions outside of historical operating ranges.

Merced River

Recreational opportunities at Lake McClure include houseboating, swimming, fishing, camping, and picnicking. Peak use is mid-May through Labor Day. During normal operations, the lake drops to low enough levels that the concessionaires must take measures to ensure that the boat access facilities remain usable. To ensure adequate supplies are available to meet contractual water needs, Lake McClure will not be drawn down below 115,000 acre-feet, so no unreasonable impacts to recreation are expected as a result of water transfer under the proposed program.

Water transfers under the proposed Supplemental Water Purchase Program in the range of previous transfers will not likely result in adverse impacts to the reservoir, downstream resources, or recreation on the Merced system.

Tuolumne River

Recreation facilities at Lake Don Pedro, operated by concessionaires, are varied. House boating, fishing, swimming, camping, and picnicking are but a few of the outdoor activities enjoyed. Potential water transfers under the proposed Supplemental Water Purchase Program are not expected to produce water levels outside the normal operating range; therefore, no significant impacts to recreation are expected.

Growth-Inducing Impacts

The proposed Supplemental Water Purchase Program will not induce growth since it would operate for a maximum of 6 years to augment State Water Project contractors' water supply in times when allocations are less than 100% of requests. Water transferred will be used for the same purposes as current entitlement contracts allow. The proposed program is designed to meet water needs during supply shortages for a 6-year period and will not provide reliable, quantified water supplies that would be needed to support population growth. Accordingly, as new reliable water supplies are added, the demand for short-term water transfers should be reduced.

The proposed program is not designed to preclude development of additional water supplies. The current State Water Project contractual commitment exceeds 4 million acre-feet; current facilities can supply only about 2.0 million acre-feet annually during extended drought periods. The short-term availability of water under this program does not decrease the need for the Department of Water Resources to continue its efforts toward further water development options.

The Drought Water Banks have shown that the supply of less-expensive water is limited and is not adequate to meet long-term commitments. Similarly, the Supplemental Water Purchase Program potential water supplies are also limited and would not be able to meet long-term commitments needed for long-term development. Consequently, the Department of Water Resources will continue its water supply development efforts and will support water conservation and water reclamation programs. The proposed program will not decrease the Department's level of activity in these areas.

No growth-inducing impacts, either direct or indirect, are expected as a result of this short-term Supplemental Water Purchase Program.

Chapter 5

POTENTIALLY SIGNIFICANT CUMULATIVE IMPACTS

This chapter discusses potential cumulative impacts that may result from consecutive annual implementation of the proposed Supplemental Water Purchase Program. Cumulative impacts, as defined by CEQA, Section 15355, refers to two or more individual effects that, when considered together, are considerable or that compound or increase other environmental impacts. This chapter identifies a number of existing or soon-to-be-implemented projects, programs, and activities that could conceivably be implemented within the life of this program that may result in cumulative impacts to various resources. A brief description of each program is provided, followed by a comparative analysis, based on likely or known impacts resulting from existing and soon to be implemented programs, relative to potential impacts that may occur from implementation of the proposed Supplemental Water Purchase Program. Projects and programs such as Monterey Agreement, Interim South Delta Water Management Program, South Delta Temporary Barriers Program, water transfers and water augmentation under the Central Valley Project Improvement Act, CALFED Bay/Delta Program, State Water Project and Central Valley Project operations, conjunctive use, Los Vaqueros, and Kern Water Bank are included in this chapter.

The proposed Supplemental Water Purchase Program is intended to be in place for 6 years. If during this period State Water Project supplies are less than maximum annual entitlement, the water would be transferred. The program would have greatest impacts if implemented in each of the 6 years. However, it is highly unlikely that transfers under this program would occur in each year. It is also unlikely that the maximum amount would be transferred in each year. Due to the large number of possible transfer combinations available, it is difficult to accurately estimate how much water might be moving through any particular system at a given time. As a result of this uncertainty, defining significant cumulative impacts is highly speculative. However, as during previous water transfers, the Department of Water Resources, in consultation with the Department of Fish and Game and local agencies, will develop a release schedule to move the water from the selling location in a manner that will attempt to provide the maximum environmental benefits while minimizing environmental impacts, taking into account operational constraints for releases and exports in the Delta. These measures should avoid significant cumulative impacts that could result from implementation of this program.

This assessment assumes that the total groundwater extraction occurring in each of the subareas remains near historical levels. Water transfers are becoming more popular, and the demand of the groundwater system could increase dramatically in the near future. The effects of other transfers on the proposed Supplemental Water Purchase Program will depend on their location. These transfers could further reduce groundwater levels and increase impacts. Until the locations and amounts of ground-

water extracted for other water transfers are known, it is not possible to evaluate the impacts or recommend mitigation.

On a valley-wide level, cumulative impacts should be minor. The total annual amount of groundwater extraction in the entire Sacramento Valley is more than tenfold greater than the proposed Supplemental Water Purchase Program extraction.

Since all impacts related to groundwater would result from lowering the groundwater levels, these impacts can be addressed if enough groundwater level information is collected as part of the proposed project. This information can be used to develop alternative extraction well layouts and spacing or to modify extraction schedules to maintain groundwater levels above historical low levels to the extent possible. Well levels and water quality will be monitored for selected irrigation and domestic wells. The ability to use real-time groundwater monitoring to provide feedback to operators will avoid problems before they might otherwise occur. If it is determined that the Supplemental Water Purchase Program contributed to impacts on water levels or water quality, affected pumpers will be offered financial compensation equal to identified well and pump modification costs and energy cost increases, as appropriate.

Water Development and Acquisition Projects

Most major water development projects involve transferring water through the Delta. New surface water developments north of the Delta, such as enlargement of Shasta Dam, Thomes-Newville Reservoir, and Cottonwood Reservoir[1], have not progressed beyond the preliminary planning stage and are too speculative to allow consideration of possible environmental effects. Other projects that improve water delivery through the Delta and store surplus water south of the Delta are near enough to implementation that they may produce cumulative effects.

Numerous studies have looked at the individual and cumulative effects of water development projects. Recent studies include those to assess effects of:

- Interim South Delta Water Management Program
- Los Vaqueros Reservoir
- Central Valley Project and State Water Project Delta operations on winter-run chinook salmon
- Temporary barriers in the southern Delta
- Coordinated Operation Agreement

The large number of historical water development projects in California have resulted in flow changes, both in streams and the Delta, with subsequent effects on water

1 These projects are not now being explored further due to economical, feasibility, or environmental concerns.

quality, fish, and wildlife. The State Water Project and Central Valley Project are the largest. Others include:

- Canyon Dam (Lake Almanor) on the North Fork Feather River, owned by Pacific Gas and Electric Company.
- New Bullards Bar Reservoir on the Yuba River, owned by Yuba County Water Agency.
- Comanche Reservoir on the Mokelumne River, owned by East Bay Municipal Utility District.
- Hetch Hetchy Reservoir on the Tuolumne River, owned by the City and County of San Francisco.
- Don Pedro Reservoir on the Tuolumne River, owned by Turlock and Modesto Irrigation Districts.
- Lake McClure on the Merced River, owned by Merced Irrigation District.
- New Hogan Reservoir on the Calaveras River, owned by the U.S. Army Corps of Engineers.
- New Melones on the Stanislaus River, owned by the U.S. Bureau of Reclamation.

As a result of many of these water development projects, several programs are in place to restore some of the losses or impacted conditions in the Sacramento and San Joaquin basins. Examples are the Upper Sacramento River Restoration Program[2] and the San Joaquin River Management Program[3].

Water Transfers Under Other Programs

A number of agencies and programs are looking for water transfers to meet certain needs, depending on hydrologic conditions. For example, in October 1995, under the Central Valley Project Improvement Act, the Department of the Interior released an Interim Water Acquisition Program Environmental Assessment[4]. The Department of the Interior is developing a program to acquire temporary water supplies to meet immediate fish and wildlife habitat restoration and enhancement needs of the CVPIA, the 1995 Water Quality Control Plan for San Francisco Bay and the Delta, and the delta smelt biological opinion. The interim program is expected to be in place from late 1995 through February 1998. In addition to the Interim Water Acquisition Program, two long-term CVPIA activities will likely impact availability of water. Specifically, the Long-Term Water Acquisition Supply Program and the annual

2 *Upper Sacramento River Fisheries and Riparian Habitat Management Plan.* 1989. Prepared for The Resources Agency by an Advisory Council Established by Senate Bill 1086.
3 San Joaquin River Management Program. 1995. *San Joaquin River Management Plan.*
4 U.S. Bureau of Reclamation. 1995. *Interim Water Acquisition Program Environmental Assessment.*

dedication of 800,000 acre-feet of Central Valley Project yield, as required by the CVPIA. Although the actual dedication of 800,000 acre-feet will not directly result in the need for water transfers, potential changes of water deliveries to Central Valley Project contractors may trigger the need for water transfers to those affected. All of these programs will require certain amounts of water to help meet their requirements for fish and wildlife.

The Department of Fish and Game may also be looking to purchase water for fish pulse flows or wildlife management areas. Logistically, this would mean that a number of entities, including the Department of Water Resources, would be looking at likely available sources of water from willing sellers. Based on Drought Water Bank experience, it is estimated that only about 400,000 acre-feet of water is available from surface water storage and groundwater substitution.

Collectively, this implies that if the Supplemental Water Purchase Program buys up all available options and can exercise the options and export the available water, then other potential buyers for environmental or other purposes would be locked out of these additional supplies for 6 years. Conversely, if these available water supplies were acquired for fish, wildlife, and other environmental benefits, there would be less water available for this program or other water transfers.

Over the life of the 6-year program, cumulative impacts resulting from this scenario could be significant to fish and wildlife that would otherwise not benefit from water transfers under the program. For example, stream-dwelling fish would likely benefit when transfers are made from reservoirs. However, it is unlikely that water transferred under this program will go to wildlife refuges. If some of the available water supply were purchased by the Central Valley Project Improvement Act, benefits to wildlife at refuges could be realized.

The current demand for water under any given water year type far exceeds the 400,000 acre-feet likely to be available if the only two sources of water are stored surface water and groundwater substitution. Because of the high demand for water, if the entire 400,000 acre-feet is not purchased and transferred under the Supplemental Water Purchase Program, one of the other entities in need, such as the CVP contractors or wildlife refuges, would likely try to obtain the available supplies. Therefore, water transfers of about 400,000 acre-feet could take place annually, as long as supplies are available and operations and conveyance facilities allow. Cumulative impacts to fish and wildlife might be reduced as a result of some of this water being made available for the benefit of fish and wildlife resources as well.

Water Augmentation Program

The U.S. Bureau of Reclamation and U.S. Fish and Wildlife Service initiated the Water Augmentation Program to comply with the Central Valley Project Improvement Act and to contribute to development of the Water Acquisition Program. Section 3408(j) of the CVPIA requires that a least-cost plan be developed that would increase the yield of the Central Valley Project by the year 2007 by the amount dedicated to fish and wildlife purposes under Section 3406(b)(2). The intent is to minimize adverse effects on Central Valley Project water contractors that might result from the dedication of water to fish and wildlife. The Water Augmentation Program has developed a report to Congress that identifies several potential methods, including long-term acquisition

of water, to replace CVP yield dedicated as "(b)(2)" water.[5] This program does not have authority to implement these recommendations. CVPIA has authorized acquisition of water for fish and wildlife purposes only.

The Water Augmentation Program also developed a discussion paper on issues involved in acquiring long-term supplemental water supplies for fish and wildlife purposes. Therefore, the Water Augmentation Program is not directly related to the Interim Water Acquisition Program but may provide some information to the development of the long-term Water Acquisition Program.

Long-Term Water Acquisition Program

During the time frame of the Interim Water Acquisition Program, the U.S. Bureau of Reclamation will develop a long-term Water Acquisition Program, which will address the acquisition of water to sustain long-term fish and wildlife water supply needs. The objectives of the long-term program are to secure long-term water supplies to supplement reoperation of the Central Valley Project and dedication of "(b)(2)" water for fish and wildlife enhancement.

If long-term water acquisition actions can be completed, implementation of the long-term Water Acquisition Program may begin during the time frame of the Interim Water Acquisition Program. The long-term program may include two components: a long-term component that would acquire water on a multi-year basis, and a short-term component that would acquire water on a single-year basis. The Bureau of Reclamation is developing specific program objectives, structure, and criteria. The long-term program is related to the Interim Water Acquisition Program only to the extent that implementation may begin during the time frame of the interim program. As long-term water supplies are acquired under this program, the annual requirements for additional water that would be acquired through the interim program may be reduced.

Potential Cumulative Impacts

Surface water impacts, as discussed in Chapter 4, including reservoir drawdown and carryover storage reductions, have the potential to occur when the water transfer programs are implemented along with the proposed Supplemental Water Purchase Program. Reservoir refill criteria, along with local reservoir operating criteria, will likely prevent significant cumulative impacts.

Groundwater-related impacts, such as reduced water levels, water quality degradation, subsidence, and surface water/groundwater interactions could be exacerbated, resulting in significant cumulative impacts, if Central Valley Project Improvement Act or other water transfer programs seek groundwater substitution in the Sacramento Valley. Significant cumulative impacts could likely be avoided by close coordination with local groundwater districts as potential buyers to ensure that total amounts of water substitution do not exceed historical groundwater extractions that occurred in previous Drought Water Banks.

5 U.S. Department of Interior. 1995. *Least-Cost CVP Yield Increase Plan.*

CALFED Bay/Delta Program

The CALFED Bay/Delta Program is a 3-phase effort to develop a long-term solution to problems affecting the San Francisco Bay/Sacramento-San Joaquin Delta estuary. The program addresses four categories of problems: ecosystem quality, water quality, water supply reliability, and system vulnerability in the event of a natural catastrophe.

Phase I has been recently completed, where the program identified the problems, developed a mission statement and several guiding principles, and designed three alternatives. In Phase II, from mid-1996 through late 1998, the program will conduct a broad-based environmental review of the three alternatives and identify the one preferred alternative. Beginning in late 1998 or early 1999 and continuing for many years, Phase III will be staged implementation of the preferred alternative.

At this time, the three alternatives each contain a number of common programs, including a wide array of actions designed to ensure efficient water use, a healthy ecosystem, better water quality, and stable levees. Additionally, several water storage options, from groundwater banking and conjunctive use to offstream storage, will be considered for each alternative.

Although it is uncertain which, if any, of the actions identified by the CALFED Program will be implemented during the life of the Supplemental Water Purchase Program, resources likely be affected by the program would include Delta water quality and Delta fish and wildlife. The CALFED Program is expected to benefit the Delta ecosystem through restoration while at the same time working to provide water supply reliability. It is conceivable that the two programs could actually compliment each other with CALFED providing environmental benefits and the proposed program addressing at least short-term water supply reliability. Consequently, no significant cumulative impacts are expected due to implementation of the Supplemental Water Purchase Program and the CALFED Program.

State Water Project

Cumulatively, the proposed Supplemental Water Purchase Program and a number of existing State Water Project programs and facilities could impact the environment in various ways. In addition, the Department of Water Resources is planning a number of programs that could have a cumulative impact in conjunction with the proposed Supplemental Water Purchase Program. The purpose of all these programs is to provide the State Water Project with a reliable water supply for municipal, industrial, and agricultural needs.

Not all the water programs will be implemented in the near future, and some will extend beyond the scope of current planning. Just how all these activities interrelate is difficult to project. Most of the current planning involves the Delta and will affect that environment. As projects are developed, continual analyses will be necessary to analyze cumulative effects on the environment, including the Delta.

Once these programs and facilities are operating under the 1995 Water Quality Control Plan, reduced water deficiencies to State Water Project contractors and improved water quality in the Delta should minimize cumulative impacts. Ideally, as these programs come on line, the need for water transfers such as those under the proposed Supplemental Water Purchase Program would be minimized and possibly eliminated. Until then, impacts to fish, wildlife, and habitat specifically resulting from the proposed program will be mitigated.

The CALFED Framework Agreement and the 1995 Water Quality Control Plan standards are expected to reduce environmental impacts in the Delta resulting from exports. In its environmental report[6], the State Water Resources Control Board indicated that if the Water Quality Control Plan standards were adopted, the Board "will reconsider its announcement that it will not approve long-term transfers that increase Delta pumping until completion of an environmental evaluation of cumulative impacts". However, there is some concern that any water transfers beyond current exports are not part of the December 15, 1994, Bay/Delta Agreement and that transfers should be addressed separately, being evaluated and mitigated on a case-by-case basis. To that end, a Delta water transfer subcommittee of the CALFED operations group was formed to determine how water transfers should be handled from an environmental standpoint with regard to exports from the Delta.

Harvey O. Banks Delta Pumping Plant

Banks Pumping Plant was built to accommodate 11 units, but only 7 were initially installed. Four additional units, each with a design capacity of 1,067 cubic feet per second, have now been installed, increasing State Water Project delivery reliability and efficiency by providing standby capacity and by permitting a larger share of the pumping to be done with off-peak power. The new units also allow a small amount of additional pumping to be shifted to winter months. The additional units change export, outflow, water quality, and fish and wildlife effects only slightly. To protect the navigable capacity of the Delta waterways near the pumps, the U.S. Army Corps of Engineers permit issued to the Department of Water Resources limits diversions into Clifton Court Forebay to historical levels.

The four additional pumps increase the capacity of Banks Pumping Plant to 10,300 cfs, bringing the California Aqueduct up to its full design capacity between the pumping plant and Bethany Reservoir. The units also increase the reliability of SWP water supply deliveries and permit the Department of Water Resources to pump more water off-peak, thereby conserving energy. During critical periods, the additional pumps could increase firm deliveries by about 60,000 acre-feet annually if the U.S. Army Corps of Engineers permit were modified.

Environmental concerns regarding the additional units at Banks Pumping Plant are addressed in an environmental impact report issued in 1989. In addition, in an agreement with the Department of Fish and Game signed in December 1986, the Department of Water Resources agreed to mitigate direct fish losses at the Banks Pumping Plant. The agreement specifies funding for projects to increase the survival

6 Appendix to 1995 State Water Resources Control Board Water Quality Control Plan.

of chinook salmon, steelhead trout, and striped bass. In cooperation with the Department of Fish and Game, the Department of Water Resources is mitigating fish losses by purchasing replacement fish, conducting a striped bass rearing program, improving upstream spawning areas and fish hatcheries, installing screens on diversions, rearing of steelhead at hatcheries, augmenting streamflow, and constructing barriers in the Delta to benefit fish.

Wheeling Water for the Central Valley Project

The State Water Project has wheeled water for the Central Valley Project for many years. That water was for:

- Replacement of up to 195,000 acre-feet per year of export lost for striped bass protection under Decision 1485,
- Delivery of up to 128,300 acre-feet per year for the Cross Valley Contractors of the Central Valley Project,
- A few small contractors under miscellaneous annual agreements.

Also, as a result of the Central Valley Project Improvement Act, the State Water Project is being asked to wheel a large amount of water to wildlife refuges south of the Delta. If the proposed Supplemental Water Purchase Program or other projects are implemented, capacity of the State Water Project to transport water for the Central Valley Project will be reduced.

The Coordinated Operation Agreement commits the parties to negotiate a separate contract specifying that excess capacity in the pumping and conveyance facilities of the State Water Project would be used to increase the amount of water the Central Valley Project can deliver from the Delta. This is a separate action, requiring a separate contract or agreement and a separate environmental impact report. With its present Delta export facilities, the Central Valley Project lacks the pumping and conveyance capacity to deliver all the water potentially available in the Delta at certain times. Currently, the State Water Project has periodic capacity in the California Aqueduct to transport a portion of Central Valley Project supplies. Further, a contract between the Department of Water Resources, U.S. Bureau of Reclamation, and Cross Valley Canal contractors in the San Joaquin Valley allows for using the State Water Project to transport Central Valley Project water when surplus capacity is available. If the proposed Supplemental Water Purchase Program or other projects are implemented, capacity of the State Water Project to transport water for Central Valley Project will be reduced.

The effect of this reduced capability for transporting Central Valley Project water could be significant from two standpoints. First, potentially less water may be available to Central Valley Project contractors in the San Joaquin Valley, which could result in changes in operations or the need to investigate alternative water supplies. Second, the lack of transportation ability could impact the ability of the Bureau of Reclamation to use State Water Project facilities to provide the fish and wildlife water required under the Central Valley Project Improvement Act.

Monterey Agreement

Conditions and circumstances with regard to water allocation and operations of the State Water Project are significantly different today than in the 1960s, when many of the contracts for SWP water were originally written. These changes have prompted agricultural, municipal and industrial SWP Contractors to scrutinize procedures of the Department of Water Resources and to consider amendments to existing water supply contracts. To avoid litigation and to make the State Water Project operate more effectively and reliably, the Department of Water Resources and the SWP Contractors engaged in mediated negotiations, which resulted in a set of principles, known as the Monterey Agreement, signed on December 1994.

The Monterey Agreement contains 14 principles that address allocation of water, potential transfer of entitlement, greater reliability of water supply, operation of terminal reservoirs in the State Water Project system, and stabilization of water rates. An environmental impact report[7], prepared for Central Coast Water Agency, addressed the possible environmental impacts that might result from implementation of the various principles in the Monterey Agreement. No significant cumulative impacts were identified in the EIR. Full implementation of the Monterey Agreement is pending litigation

Interim South Delta Program

The Interim South Delta Program is a joint planning program involving the Department of Water Resources and the U. S. Bureau of Reclamation. Its purpose is to improve water levels and circulation in southern Delta channels for agricultural diversions and to improve hydraulic conditions to allow increased diversions into Clifton Court Forebay so Banks Pumping Plant can operate as efficiently as possible.

Before the Interim South Delta Program, the Department of Water Resources and U.S. Bureau of Reclamation were jointly involved in the South Delta Water Management Program, but the proproposal was not finalized. The preferred alternative of the Interim South Delta Program addresses previously unresolved issues and recommends the following actions:

- Construct a new intake structure at the northeast end of Clifton Court Forebay.
- Install three flow control structures in southern Delta channels.
- Build one fish control structure.
- Dredge nearly 5 miles of Old River between Woodward Canal and West Canal.

The Draft EIS/EIR for the Interim South Delta Program was released in August 1996.[8]

7 Science Applications International Corporation. 1995. *Environmental Impact Report, Implementation of the Monterey Agreement.* Prepared for Central Coast Water Agency.

8 Department of Water Resources and U.S. Bureau of Reclamation. 1996. *Draft Environmental Impact Report/Environmental Impact Statement, Interim South Delta Program.* DWR, Sacramento.

Cumulative impacts associated with the above State Water Project activities could occur primarily with water quality and fish related to Delta exports. The proposed program expects to either avoid or fully mitigate impacts by a number of ways, including limiting export period to a July-October window, provide carriage water as needed to provide for Delta water quality and mitigation of fish losses through the 4-Pumps Agreement. Additionally, the State Water Project is operating under the 1995 Water Quality Control Plan and biological opinions for winter-run chinook salmon and delta smelt.

All existing and proposed programs within the Department of Water Resources would be expected to operate with the regulatory framework that is currently set up to avoid significant impacts in the Delta. Additionally, the Department of Water Resources is an active participant in the CALFED operations group that is working to resolve issues that come up regarding operations related to State Water Project exports. As a result of these measures, no significant cumulative impacts to Delta resources are expected during the 6-year life of the proposed Supplemental Water Purchase Program.

Conjunctive Use

The Department of Water Resources has identified several project areas in the Sacramento Valley for conjunctive operation with the State Water Project. The Butte Basin and Eastern Yolo County conjunctive use projects are in areas where Supplemental Water Purchase Program extraction may occur, and they will have to operate in close coordination to assure that combined operations do not create undesirable impacts. Moreover, other interests are looking at conjunctive use projects in the Sacramento Valley. Until these programs are better defined it is not possible to evaluate their effects on the proposed project.

The Department of Water Resources continues to work with local agencies and other interested parties to address concerns arising from additional use of groundwater and water transfers and to enhance recognition of the potential for conjunctive use as an element of overall resource management. Local agencies are continuing to develop groundwater management programs, although resolving local conflicts has slowed adoption and implications for conjunctive use remain uncertain.

Other Projects

Several projects other than those proposed under the State Water Project are being implemented or are under construction. Identified below are those projects that could have significant cumulative impacts if the proposed Supplemental Water Purchase Program is implemented.

Los Vaqueros Reservoir

In 1994, Contra Costa Water District began construction of the Los Vaqueros Project, which includes a 1,500-acre reservoir to be supplied by a new export facility on Old River near Highway 4. The primary purpose of the reservoir is to store up to 100,000 acre-feet of good quality water drawn from the Delta, primarily in winter, for blending with other Delta water drawn in seasons with more saline conditions. Other reservoir purposes include backup water storage, flood control, and recreational use. Los Vaqueros reservoir is scheduled to be completed in 1997.

The intake facility, just south of Discovery Bay on Old River, will consist of a screened pumping plant with maximum capacity of 250 cubic feet per second. Water will be transported via pipeline to a transfer facility with a slightly smaller pumping plant, west of Byron, where water can be routed either south to the reservoir or north to the Contra Costa Canal near Antioch.

Los Vaqueros Reservoir would accommodate 100,000 acre-feet of water with a maximum allocation of:

- 56,000 acre-feet of emergency storage,
- 30,000 acre-feet of water quality enhancement storage,
- 10,000 acre-feet of unused storage, and
- 4,000 acre-feet of evaporation storage.

The size of the reservoir was developed to provide a 90-day emergency supply for Contra Costa Water District at the peak 3-month demand level at buildout during wet and normal years, assuming customer cutbacks of 25 percent during the emergency period. During critical years or a series of such years, up to 26,000 acre-feet of the emergency storage may be used for water quality blending in addition to the 30,000 acre-feet of water quality enhancement storage. Under these circumstances, the remaining 30,000 acre-feet of emergency supply (enough for about 30 days at peak demand level at buildout) will be maintained in the reservoir for use during an emergency.

An amount of water equivalent to the estimated Kellogg Creek inflow, up to 5 cubic feet per second, would be released to Kellogg Creek downstream of the dam. Also, Contra Costa Water District would release enough water from the reservoir to maintain perennial pools and wetlands along Kellogg Creek within about a mile downstream of the dam, which may require releasing additional flows to Kellogg Creek. Simulations indicate that Kellogg Creek has no measurable flow about 62 percent of the time and has flows exceeding 5 cubic feet per second about 6 percent of the time.

In wetter years, Contra Costa Water District may increase diversions from the Delta by as much as 40,000 acre-feet and store that water in Los Vaqueros Reservoir. In dry years, when Contra Costa Water District uses stored water, diversions from the Delta may be reduced by as much as 40,000 acre-feet. Over a simulated 57-year study period, these diversion increases and decreases balanced, except for evaporation losses from the reservoir. To make up for evaporation losses, Contra Costa Water District's net

Delta diversions with the proposed project will increase by an average of 3,300 acre-feet per year.

If Los Vaqueros is completed and operational at some time during the 6-year life of the proposed Supplemental Water Purchase Program, it could conceivably result in significant cumulative impacts to water quality and fish in the Delta resulting from increased exports. However, it is assumed that the two projects will be operated under criteria established by the State Water Resources Control Board and, thus, any impacts will be avoided, reduced to insignificance, or mitigated as described in Chapter 4.

Kern Water Bank

The Kern Water Bank is a conjunctive use groundwater banking program that was proposed by the Department of Water Resources in cooperation with Kern County Water Agency and local water districts. The Kern Water Bank is broadly defined as all opportunities to store and extract water in the Kern County groundwater basin. The purpose of the Kern Water Bank program was to augment the dependable water supply of the State Water Project by storing water available from the Delta during wet periods in the Kern County groundwater basin for use during dry periods.

During wet periods, the Department of Water Resources would convey surplus water directly to recharge ponds or to local water districts for use in lieu of their pumping from groundwater storage. In dry periods, water would be extracted from storage. In some cases, the extracted water would be conveyed directly to the California Aqueduct to supplement State Water Project water supply; in other cases, it would be used by local districts in exchange for an equivalent amount of their State Water Project entitlement water. Their entitlement would then be added to the amount of State Water Project water available for delivery to other SWP contractors.

The proposed Kern Water Bank consisted of eight separate projects or elements. In 1988, the Department of Water Resources purchased 20,000 acres overlying the Kern River alluvial fan for a direct recharge project known as the Kern Fan Element. Seven other "local elements" involving direct and in-lieu recharge programs were proposed by local water districts in Kern County to expand their conjunctive use capabilities and were studied under the Kern Water Bank planning efforts. Together, the eight elements could store as much as 3 million acre-feet of water and, under 1988 regulations controlling Delta exports, provide about 400,000 acre-feet of additional water in dry and critically-dry years.

As a result of the proposed new Delta standards and the Endangered Species Act protections for the winter-run salmon and delta smelt, the water supply for new facilities south of Banks Pumping Plant became uncertain. In addition, a greater need developed than originally expected for the local use of existing recharge and conveyance facilities, making the use of these facilities by the State Water Project as part of the Kern Fan Element no longer realistic. Consequently, design activities for the Kern Fan Element and all planning activities for the local elements were discontinued in spring 1993. At that point, the program emphasis was directed toward reevaluating the economic viability of the Kern Fan Element in consideration of the water supply uncertainties and developing environmental impact mitigation measures and a habitat conservation plan for the Kern Fan Element.

The Department's efforts to implement the Kern Fan Element effectively ended in December 1994 with the signing of the Monterey Agreement, which among other provisions set the principles for transferring the Kern Fan Element property from the Department to designated agricultural contractors (primarily Kern County Water Agency) in exchange for the retirement of 45,000 acre-feet of State Water Project annual entitlement. The Kern Water Bank Authority, a public agency formed under a joint powers agreement, was created to operate a groundwater banking project on the Kern Fan Element for the benefit of the participating local water agencies. The Kern Water Bank Authority will likely use a variety of water sources for groundwater recharge, including the State Water Project, Central Valley Project, Friant-Kern, Kern River floodflows, and other sources that may include supplemental water purchases.

Future consideration of Department of Water Resources participation in any of the Kern Water Bank local elements may be included in a program that encompasses all opportunities for conjunctive use in the San Joaquin Valley. It is unclear what cumulative impacts, if any, may result when the Kern Water Bank is operated. Therefore, it would be highly speculative to attempt to identify the potential impacts and appropriate mitigation measures.

Summary of Cumulative Impact Analysis

The nature of the proposed Supplemental Water Purchase Program, specifically, acquisition of up to 400,000 acre-feet of water from various sources, along with the regulatory framework currently in place make the potential for significant cumulative impacts unlikely over the life of the proposed program.

Refill criteria and local reservoir operating criteria should avoid significant cumulative impacts to surface waters. Significant cumulative impacts related to groundwater substitution will be avoided by monitoring to identify possible problems and employing a menu of measures to limit impacts to as few years as possible if they do occur, including discontinuing pumping in some areas.

Cumulative impacts related to exports from the Delta to water quality and fish will be avoided by requiring the exporters to operate under the 1995 Water Quality Control Plan as well as endangered species act biological opinions for winter-run chinook salmon and delta smelt.

No significant cumulative impacts on the environment are expected as a result of implementation of the proposed program.

Chapter 6

IRREVERSIBLE AND UNAVOIDABLE IMPACTS

CEQA requires that lead agencies address irreversible or unavoidable significant adverse environmental impacts that may result from a proposed project. With the exception of some reservoir-based recreation, no significant irreversible or unavoidable impacts are expected as a result of this proposed program. However, in the interest of thoroughness, this chapter contains a discussion of other areas where irreversible or unavoidable impacts may occur but are not expected to be significant.

The proposed Supplemental Water Purchase Program will be carried out for a period of up to 6 consecutive years. However, it is not likely that transfers under the proposed program will occur in each of the 6 years. It is expected that if there are unavoidable adverse impacts, they will be temporary and will be either eliminated after the 6-year life of the program or sooner if transfers do not take place in consecutive years.

One possible irreversible impact could be land subsidence resulting from use of groundwater for transfer. Although the program will not be attempting to use wells in areas of known subsidence, there is a remote possibility that some subsidence could occur in areas previously unknown to have potential for subsidence. Subsidence, for the most part, is irreversible, and although monitoring can detect subsidence after the fact, there is no way to mitigate specifically for it.

A number of unavoidable impacts could result from the proposed program, although some will be mitigated for. Unavoidable but minor increases in to energy consumption are likely in the event the program is implemented. This would result from an increase in energy consumption in the geographic area where the groundwater pumping is likely to occur and from increased State Water Project pumping.

In addition to increased energy consumption, groundwater substitution under this program could unavoidably result in lowered groundwater levels in wells being used for the program, as well as some adjacent wells. Historical information indicates that the lower levels would be a temporary phenomenon, and levels are likely to return to normal. It is expected that monitoring groundwater levels and carefully spacing wells used for this groundwater substitution will minimize the potential for this unavoidable but reversible impact.

Unavoidable impacts to fish in the Delta as a result of increased pumping at Harvey O. Banks Delta Pumping Plant will likely result in additional losses. Direct losses of fish will be minimized by transferring water at the pumps during a July-October window. In additional, using fish salvage data, the Department of Water Resources will compensate for losses through the Four-Pumps Agreement. On the whole, program-wide losses to fish are unlikely to be a significant environmental impact.

Summer recreational use at some reservoirs may be reduced as a result of the proposed Supplemental Water Purchase Program. Some reservoirs could be lowered earlier in the summer than they would under conditions without the program. This would result in less water-related recreational opportunities than typical during peak recreation periods. Although the Department of Water Resources will work closely with reservoir operators to avoid or minimize this impact, the potential is compounded in part due to the need for scheduling reservoir water releases to avoid fish-attraction flows, which may sometimes conflict with the recreation period. Ultimately some significant unavoidable impacts to recreation could occur under this program. These impacts would be temporary because water levels will increase from normal hydrologic cycles. However, they could still be significant to recreation concessionaires that rely on a certain level of recreation use annually for their livelihood.

Chapter 7
PROGRAM ALTERNATIVES

The proposed Supplemental Water Purchase Program could provide up to an estimated 400,000 acre-feet of water annually to State Water Project contractors to make up deficiencies in their SWP supplies. This water could be made available as soon as the necessary contract agreements and regulatory approvals are executed. Because this program would further the intent of recent California legislation promoting water transfers[1] and the Governor's Water Policy with minor adverse impacts, the Supplemental Water Purchase Program described in Chapter 2 is the preferred alternative.

The following alternatives to the proposed program could be implemented and are evaluated in this chapter:

Alternative 1 — No Supplemental Water Purchase Program.

Alternative 2 — Supplemental Water Purchases of Only Surface Water Supplies.

Alternative 3 — Agricultural Fallowing and Crop Substitution.

Alternative 4 — Increased Water Conservation and Demand Reduction Activities.

In addition, development of various other water production methods was considered, some of which are fairly innovative and untested. Due to the long time lag before these programs could be implemented and due to uncertainties of the amount of water that could be produced, such alternatives were determined to be infeasible within the necessary time-frame of this program. However, other possible water production methods considered are described briefly in the last section of this chapter.

Of the feasible alternatives, Alternative 1, the no-program alternative, appears least desirable, because various potential program benefits will continue to be unrealized. Since the proposed water transfers would be fair-market transactions, it is likely that both buyers and sellers and their local economies will benefit from implementation of some type of program. Also, although a water transfer program may result in minor unforeseen costs or environmental consequences, the probable benefits are significant. One great benefit would be program management information that will be gained and that will allow future adjustments of the program to minimize environmental impacts and maximize economic benefits. By contrast, the no-program alternative represents a "nothing ventured / nothing gained" scenario.

Alternative 2 would only provide about half as much water as the proposed program, thereby failing to meet a basic objective. Also, it would limit program flexibility by eliminating the capability for groundwater substitution programs. However,

1 Assembly Bill 2897, Chapter 481, Statutes of 1992.

generally considering potential adverse impacts in source regions and potential benefits to both sellers and buyers, it appears that a Supplemental Water Purchase Program involving only surface water sources in existing reservoirs is likely the environmentally superior alternative.

Alternative 3 could provide a considerable amount of water for transfer by encouraging farmers and ranchers in regions with surplus water to use less water by changing crops, changing farming methods, or fallowing agricultural land. Based on experience during previous Drought Water Banks, an estimated 300,000 to 400,000 acre-feet of water could be freed for transfer by implementing various types of fallowing or crop substitution programs. However, the supplying regions of a widespread agricultural fallowing program could experience significant adverse environmental and socioeconomic impacts. Considerable additional study of the overall costs and benefits of regional fallowing programs would be necessary to better identify environmental impacts and quantify statewide net costs or benefits before implementing a large-scale fallowing or crop substitution program. This could not be accomplished soon enough to provide a few hundred thousand acre-feet of water within 6 years.

Alternative 4 is not thought to be fully viable for implementation in the immediate future, as would the proposed program. Rigorous implementation of Alternative 4 — requiring immediate water conservation and demand reduction programs —would certainly be much more costly than the proposed program because of the need to improve water distribution facilities at all organizational levels. It would also require more time to achieve the desired amount of water savings and, although it is prudent to continue to improve water conservation measures, as a practical matter they will only become implementable over a longer planning horizon.

In summary, various alternatives to the proposed program were considered for implementation either in lieu of the proposed program or as part of it. However, none was able to adequately meet basic program goals of providing about 400,000 acre-feet annually within the next 6 years with less significant adverse environmental impacts. Much less water would be realized with all viable alternatives, and there are uncertainties about the full spectrum and magnitude of environmental impacts and program costs for fallowing programs and water conservation/demand reduction activities. The latter two and other infeasible alternatives considered would also not meet the proposed schedule for implementation. Therefore, these analyses led to the conclusion that transfer of water purchased from reservoir storage or groundwater substitution is the best way to substantially meet the objectives of the overall program while avoiding or minimizing significant adverse environmental impacts.

Alternative 1 No-Program Alternative

The no-program alternative would have no Supplemental Water Purchase Program, although some Drought Water Bank transfers might occur. State Water Project and Central Valley Project facilities would pump and convey less water in normal and below-normal years under this alternative as a result of less water being available for entitlement exports. With no Supplemental Water Purchase Program transfers, there

would be less flow in rivers tributary to the Delta in late summer than if a water transfer program existed. For example, the lack of transfers from Feather River water users would result in lower flows in the Feather River as well as the Sacramento River below the confluence with the Feather River. Similarly, there could be lower summer and fall flows in tributaries to the San Joaquin River above its entry to the Delta at Vernalis than there would be with the program.

In general, the no-program alternative would have higher surface water diversions in summer from streams tributary to the Delta than there would be under the proposed Supplemental Water Purchase Program.

Operational flexibility of the State Water Project and Central Valley Project would be less under the no-program alternative. This was apparent when the Drought Water Banks in 1991, 1992, and 1994 increased flexibility in SWP and CVP operations (as is expected to take place under the proposed Supplemental Water Purchase Program). Additional amounts of water were stored in Lake Shasta during critical portions of the year than would otherwise have occurred in those years, resulting in water temperature benefits to winter-run chinook salmon. In 1994, water was stored in Folsom Lake to benefit fall-run chinook. The Supplemental Water Purchase Program might result in increased spring/summer storage in these and other Northern California reservoirs as well.

The Supplemental Water Purchase Program is intended to reduce economic, environmental, and social impacts of water shortages in areas receiving the water. In such areas, the no-project alternative may have adverse environmental effects compared to the proposed program. Necessary water would not be supplied, possibly resulting in loss of both permanent and high-value crops, expensive landscaping, and industrial production. Increased groundwater overdraft could also result. Other potential adverse impacts associated with the no-program alternative include:

- Loss of groundwater recharge capability in water-deficient areas.
- Degradation of water quality in water-deficient areas.
- Reduced water available for agriculture.
- Higher water supply costs for construction of new wells in marginal areas.
- Reduced business confidence and investment in water-deficient areas.
- Increased expenditures for high-cost conservation measures by water-sensitive industries.
- Significant economic losses and increased unemployment in water-deficient areas.
- Reduced economic benefits to water sellers.

Urban areas experience significant adverse economic impacts from water shortages. Water is critical to production processes for a number of California's high technology industries. California's continued economic health is vulnerable to plant expansion and relocation decisions by these key industries. Many of these industries are considering new plant facilities outside California due to concerns about the lack of reliable

water supplies for expanded plant production. Improved reliability of water supply will help keep valuable industries in California.

The green industry, composed of landscape and nursery industries, lost 33,000 jobs (17 percent of the workforce employed in this field) in 1991 due to drought and recession impacts[2]. This industry is especially vulnerable to water supply shortages. Other industries, such as construction and tourism, which provide employment to large numbers of people, are also vulnerable to water shortages. Agriculture will also suffer from reduced water supply reliability.

Water shortages to State Water Project agricultural service areas usually result in an increase in the amount of groundwater pumped to make up for the surface water shortfall. This results in either a temporary or permanent overdraft of the groundwater basin. The overdraft causes a decline in groundwater levels, which in turn can result in increased energy costs to get the water to the surface, decreased pumping quantities, modifications to the well pump bowls to keep them below the groundwater level, and/or abandonment of the well. The overdraft can also cause subsidence in the immediate area, which results in damage to local infrastructure such as canals, roads, pumps, and bridges.

In portions of State Water Project service areas where groundwater is not available, water shortages result in direct loss of crop production. This affects farmers, farm workers, and local businesses that support the agricultural economy.

Loss of Fish and Wildlife Benefits

With reduced pumping in the Delta under the no-program alternative, there would be less direct and indirect fish losses at the pumping plants during late summer. However, greater water diversions from tributaries would likely result in greater fish losses at upstream unscreened water intakes compared to the Supplemental Water Purchase Program. Under the no-program alternative, loss of operational flexibility, which allows increased storage behind certain reservoirs, could result in significant harm to fish species such as the winter-run chinook salmon, which is listed under both the State and Federal Endangered Species Acts.

Fish and wildlife species that could benefit from the proposed Supplemental Water Purchase Program by augmented streamflows and associated maintenance of riparian vegetation and wetland habitat would not receive these benefits under the no-program alternative. The impacts to fish and wildlife species dependent on salinity control from fresh water flow in the Bay/Delta estuary complex would be similar to those of the Supplemental Water Purchase Program.

Independent Water Transfers

The no-program alternative could result in State Water Project contractors entering into their own water transfer deals with willing sellers. Like the proposed program, these transfers would require conveyance through the Delta and would still be subject

2 D.L. Mitchell, 1993. *Water Marketing in California: Resolving Third-Party Impact Issues.* Bay Area Economic Team and Metropolitan Water District of Southern California. Foster Economics, San Francisco.

to all the regulatory requirements (including CEQA) that the proposed program must satisfy. It is possible that a similar amount of water from the same sources identified under the proposed program could be obtained, potentially resulting in the same types of environmental impacts as described in Chapters 4 and 5.

However, the inability to programmatically manage or evaluate transfers by individual buyers and sellers entering independent water transfer contracts could result in more significant impacts. A piecemeal approach would lead to discontinuity, foster public distrust of the water transfer process, and make it impossible to identify and address cumulative impacts of all water transfer deals. This could portray an image that water transfers are contrary to the intent of CEQA.

Another disadvantage of this scenario would be even greater reductions in operational flexibility as compared to the proposed project. Operational tools such as "backing water" into storage facilities, "ramping" downstream releases, coordinated timing of releases, and improved scheduling of pumping out of the Delta that provide the ability to minimize or eliminate adverse environmental impacts could be implemented much more effectively in an overall program than in an unpredictable, uncoordinated multitude of smaller transfers. Additional significant adverse environmental impacts could occur absent the ability to look at the overall picture of proposed transfers, because this allows the regulatory agencies to recommend release schedules, pumping periods, conveyance windows, and so forth and, where appropriate, identify mitigation measures to minimize or eliminate significant environmental impacts.

Therefore, the possibility of multiple independent water transfers occurring with the no-program alternative, potentially transferring as much water as the proposed program, could ultimately have more adverse environmental impacts than the proposed Supplemental Water Purchase Program.

Alternative 2 Supplemental Water Purchases Using Surface Water Supplies Only

It would be possible to develop a water transfer program similar to the preferred alternative that does not involve groundwater exchanges. An estimated 200,000 acre-feet of surface water would be available annually for this program during the next 6 years. A Supplemental Water Purchase Program using only excess surface water supplies available from willing sellers would thereby provide about half as much water to the State Water Contractors as the preferred alternative.

Using only excess surface water supplies would eliminate a number of potential adverse environmental impacts associated with conjunctive use of groundwater. Potential adverse groundwater extraction impacts that would be avoided include lowering the water table, altering groundwater quality, inducing land subsidence, and associated direct and indirect economic losses. There would no longer be a hazard of aquifer drawdowns in areas where landowners choose to enter groundwater exchange agreements, eliminating the possibility of local offsite impacts to neighboring wells due to the program.

A Supplemental Water Purchase Program involving transfers of only excess surface water supplies would also be much easier for the Department of Water Resources to administer. Water stored in reservoirs is easier to quantify, because relatively reliable records of refill patterns, release schedules, flow rates and other typical operations are available. Accordingly, operational criteria specifying standards for releases, flow schedules, carryover storage, and refill requirements, and supplemental water purchase contracts could be fairly well defined. Furthermore, the need for mitigation monitoring would be reduced greatly because it would not be necessary to study adverse impacts that might be associated with groundwater extraction.

Despite the probable reduction in Department of Water Resources administrative activities required to implement a transfer program involving only surface water, this alternative is not preferred for two main reasons. It would not provide as much water as desirable according to program objectives. Probably more important, the Supplemental Water Purchase Program would have greatly reduced operational flexibility for procuring supplies and subsequent minimizing of impacts as discussed below.

Conjunctive use has inherent advantages of providing more potential suppliers and water sources, greatly increasing operational flexibility from year to year and providing the ability to recover in the event of over-allocations from any particular source. Potential surface water supplies can be estimated using probabilities derived from historical records, but they cannot be guaranteed with certainty because they depend on annual weather patterns. Likewise, groundwater supplies and pumping impacts can be estimated from known information but cannot be well quantified without additional information gained from monitoring extractions. If either source were overused somewhere in a particular year or season, the adverse impacts of water supply depletion could be minimized by adjusting the use of the other source.

In summary, Alternative 2 would involve voluntary purchases of excess surface water supplies stored in reservoirs and would exclude groundwater substitution from the program. Although this alternative would be easier to administer because it would eliminate the potential adverse impacts of groundwater extraction in supplying regions, it would make only about 200,000 acre-feet of water available for transfer — half as much as with the preferred Supplemental Water Purchase Program. In addition, it would limit the overall operational flexibility of the water transfer program, mainly from year to year, because conjunctive use of both possible sources increases the capability to recover in the event of excessive depletion of either source. For these reasons, this alternative would not meet the objectives of a statewide water transfer program. It would not provide an adequate amount of water nor would it provide the increased flexibility to mitigate for potential adverse environmental impacts that may occur in the event that too much surface water is transferred from a supplying region. So although this alternative might be considered environmentally superior by avoiding potential groundwater substitution impacts, it is not as efficient as the preferred alternative in meeting program objectives.

Alternative 3
Agricultural Fallowing and Crop Substitution

While planning for the Drought Water Bank, fallowing agricultural land was identified as a means of saving water in supplying regions for transfer to water-deficient areas.[3] For Drought Water Bank purposes, it was estimated that development of fallowing and crop substitution programs would become practicable when critical needs exceeded a threshold of about 400,000 acre-feet. Based on the 1991 Drought Water Bank, for critical water needs the best approximation of potential statewide yield for a managed crop-fallowing program to generate surplus water that could be available for transfers is about 300,000 to 400,000 acre-feet. This amount would not likely be a desirable source in consecutive years, as significant impacts to third parties would likely result.

Although the basic premise that water can be saved through fallowing is sound, implementing such a program on a statewide or regional basis would be complex. Key issues to be addressed would be identifying baseline water use and cropping patterns of water suppliers, monitoring agricultural practices to verify water savings, and minimizing or mitigating significant adverse economic and environmental impacts.

Fallowing and Crop Substitution Methods and Possible Socioeconomic Impacts

Fallowing and crop substitution programs could be used in supplying regions to make water available for purchases by three basic methods:

- Withholding future irrigation of planted crops.
- Substituting more water-efficient crops than normal.
- Total fallowing, or not planting any crop.

Farmers would be paid in accordance with options contracts similar to those under the preferred alternative except that the purchased water would have normally been applied for existing crop production. This would have much greater potential for creating indirect regional socioeconomic impacts.

With the first method, the farmer would receive direct payment from selling the water that would have been consumptively used by crops already planted. Crop production costs would be reduced, but the farmer would have to accept a reduced or total loss of crop revenue. Since this program would be voluntary, it is assumed that the farmer would receive enough payment to at least cover the lost crop revenue. Depending on the time during the crop's season that further irrigation is withheld, this option could have adverse regional socioeconomic impacts. If irrigation is terminated relatively late in the season, then most growing expenses (except harvesting) have already been incurred and the regional effects will be less. However, if irrigation is terminated relatively early in the season, then more expenses will be foregone, with greater

3 Department of Water Resources. 1993. *State Drought Water Bank.* Program Environmental Impact Report. 210 pages plus appendixes.

impacts to regional income. The farmer's expenditures after irrigation is terminated, such as equipment purchases, field maintenance, or improvements (such as to irrigation systems) will also be important. Thus, some farm suppliers may not be significantly effected. However, if the harvest is reduced or eliminated, then those firms and labor involved with processing and distributing would be affected.

The second fallowing method would compensate farmers for substituting crops with lower water requirements than normally would be grown. This method would be implemented before the planting decision is made, and the farmer would receive revenue from water savings that are sold. However, the farmer's crop revenues would probably be less. Again, since this would be a voluntary program, the farmer would be expected to at least break even, but crop substitution could also have regional economic effects. Farm suppliers could be negatively or positively affected, depending on the new crop and the pattern of expenditures needed to bring that crop to harvest. Expenditures for seed, fertilizers, pesticides, and farm labor would likely be different than for the original crop. Effects on processors and distributors would depend on the type of replacement crop and the requirements specific to that crop as compared to what would have been planted without the program.

A variation of crop substitution, sometimes called "crop shifting", would involve changing to crops with a different growing season. In fall 1991, Central Delta Water Agency proposed to generate water for a Drought Water Bank transfer by paying Delta farmers to shift from summer field to winter grain crops. The Department of Water Resources conducted a limited crop shifting study on 1,611 acres of Rindge Tract, a Delta island, from fall 1992 through spring 1994.[4] The pilot project involved changing from summer corn to winter wheat production on a portion of the area. Although this saved an estimated 1.17 acre-foot of water per acre, technical limitations, specific site parameters, and complications due to unusual weather and streamflow patterns caused a high degree of uncertainty about the applicability of these results to other areas, especially on a regional scale.

The study concluded that seasonal crop shifting was not likely to be practicable as a major source of water for transfers. Reasons included the probability of highly variable results for different regions and crops, the relatively high cost per acre-foot of water saved, and the lack of operational flexibility for farmers due to the requirement for them to commit early in the water year — before the need and value of saved water could be determined. Such a program would require more study and fairly intensive monitoring throughout the farming regions of California before this method could be used for quantifiable water production.

In addition to evaluating water savings for the Rindge Tract study, the Department of Water Resources and the Department of Fish and Game cooperated to evaluate impacts to wildlife and fish and the effectiveness of wildlife mitigation measures prescribed to minimize impacts of the crop shifting study.[5] Due to the relatively small scale of the pilot program, it was not possible to determine any impacts to Delta fish.

4 DWR. 1994. *1992-93 Delta Crop-Shift Demonstration Project, Preliminary Assessment.* Central District Memorandum Report. Sacramento.

5 DWR. 1995. *Delta Crop-Shift Demonstration Project, Wildlife and Mitigation Compliance Monitoring.* Final Report, Environmental Services Office, Sacramento.

Results of wildlife surveys indicated no detectable adverse impacts to any species and a likelihood that some species, particularly waterfowl, benefited from the greater diversity of forage conditions created by the increased acreage of winter wheat. Mitigation measures such as flooding some fields in fall and winter, retaining a small percentage of unharvested crops, and planting companion wildlife forage species appeared to be valuable in maintaining wildlife habitat values.

The relatively small scale of the pilot study area limited the degree to which wildlife and fish impact assessments could be extrapolated for fallowing or crop substitution programs applied over larger regions. Planning programs to maintain diverse habitat conditions geographically, seasonally, and from year to year would probably result in little or no overall negative impact to wildlife and would likely produce benefits.

The third method, total fallowing, could have the most significant adverse effects on sellers and the source regional economy. The farmer would obtain revenue from the water sales, would have reduced or no production costs, and would forego crop revenues. As with the other two options, it is assumed that farmers would estimate the net benefits of the program and participate only if net benefits are positive. Generally only annual field crops would be included in this type of fallowing program.

Farm suppliers, processors, and distributors would be affected by complete fallowing, although the effects are likely to be complex. For example, farm suppliers would be negatively affected as farmers reduce or eliminate purchases of seed, fertilizers, and pesticides. However, farmers might continue to maintain the land, make capital improvements, and purchase equipment, so some suppliers might be affected less than others. Distributors and processors would likely be the most adversely affected when a crop is not produced. The extent of such effects would depend on the ability of distributors and processors to substitute crops grown in other areas. Employment effects are also likely to be complex. Although the farmer would likely hire fewer managers and laborers while land was fallow, some workers might be needed to maintain or improve the land. Farmers might forego hiring part-time help but retain full-time employees.

The option of withholding irrigation from crops could, to some extent, adversely affect workers who harvest and process farm produce, but since crops would probably still be produced in lower quantity or quality, some harvesting and processing would still be required. The option of substituting lower-water-use crops for higher-water-use crops is not expected to significantly affect community services, because crops would still be brought to harvest. The difference in labor requirements for harvesting and processing the new crop compared to those for the crop it replaced could affect the local economy to some degree. Of the various fallowing and crop substitution options, total fallowing would have the greatest potential to create unemployment among farm workers and in related agricultural businesses.

Economic Effects of 1991 Drought Water Bank

The Rand Corporation prepared a general evaluation of the economic effects of the 1991 Drought Water Bank[6] and completed a detailed evaluation of the economic

6 Rand. 1993. *Assessment of the Economic Impacts of California's Drought on Urban Areas.*

impacts in the exporting areas.[7] In addition, the University of California, Davis, Agricultural Issues Center and the University of California, Riverside, Water Resources Center jointly studied the economic, social, and environmental impacts of the 1991 Drought Water Bank in Yolo and Solano counties.[8] The economic effects of water transfers under the 1991 Water Bank are probably indicative of the maximum effects that could be expected under the proposed Supplemental Water Purchase Program combined with fallowing.

The Rand Corporation study evaluated statewide net income and employment effects (direct, indirect, and induced) in the exporting and importing regions. In the exporting region, it was estimated that the net income lost from fallowing crops exceeded the income gained from water sales by about $12.8 million, including county income multiplier effects. Individual water sellers who fallowed their land gained from higher net incomes from water sales and reduced cultivation and harvesting costs. Also, in some cases, farmers credited for non-irrigation were able to achieve normal or near-normal yields because of rainfall subsequent to water sales. Third-party impacts in these cases were non-existent or minimal. In the importing regions, the project resulted in a net income gain to agriculture of about $45 million. Urban users were able to gain from the avoidance of the social and economic cost of imposing further rationing or conservation measures. Assuming that these additional measures were at least as costly as a conservatively estimated value of water during normal years, the urban gain was about $59 million. Thus, the total gain was about $104 million, representing a net gain to the State of about $91 million.

Employment effects were similar to the net income effects. In the exporting region, employment lost to fallowing exceeded employment created from water sales revenues by about 162 jobs. However, in the importing region, about 1,153 jobs were gained. Thus, there was a net employment benefit to the State of about 991 jobs.

Although there were net declines in income and employment in the exporting region, the study concludes that these losses were relatively minor compared to overall county income and employment levels.

The University of California study focused on impacts of the 1991 Water Bank in Yolo and Solano counties, which were the source of about 196,000 acre-feet of water. In Solano County, about 42,000 acre-feet for the Drought Water Bank and 15,000 acre-feet for the Solano County Emergency Water Pool was obtained by fallowing about 24,000 acres in Solano County. About 97,000 acre-feet for the Drought Water Bank was obtained by fallowing about 46,000 acres in Yolo County. The remaining 57,000 acre-feet for the Water Bank from Yolo County was obtained through groundwater and groundwater substitution contracts.

The University of California study found that direct, on-farm jobs dropped about 5 percent in both counties in response to crop fallowing for water transfers. Total county income and employment in the agricultural sector (which includes all businesses allied with agriculture) dropped a maximum of about 5 percent in Yolo County and about 3.5 percent in Solano County. A scientific survey of businesses allied with

7 Rand. 1993. *California's 1991 Drought Water Bank, Economic Impacts in Selling Regions.* Santa Monica, CA.
8 University of California, Davis. 1993. *California Water Transfers: Gainers and Losers in Two Northern Counties.* Proceedings of a conference sponsored by Agricultural Issues Center and Water Resources Center on November 4, 1992, Sacramento, CA.

agriculture revealed that about 62 percent experienced no effect from water transfers on their sales, about 31 percent experienced a decrease in sales, and about 6 percent experienced an increase in sales.

In addition, Rand has completed an evaluation[9] of impacts of the Drought Water Bank on third parties, with a major focus on the change in farm operating expenditures and crop sales due to operation of the water bank. The size of farm expenditures and sales is a good indicator of the amount of local business activity supported by agriculture. Preliminary results suggest that the Bank did cause substantial declines in the operating expenditures and crop sales of farmers who participated in the Bank, but these drops were small relative to the overall operating expenses and crops sales in the counties affected. For example, it appears that operating costs fell 15 to 20 percent for farmers with fallowing contracts and caused operating costs in the counties primarily affected by the Bank to fall approximately 3 percent. Farmers who participated in the Bank appear to have spent some of their Bank revenues on farm investment. This partially offset the decline in operating expenditures, although the people who benefited are not necessarily the same ones hurt by lower operating expenditures. Rand's analysis also suggests that fallowing some crops had larger impacts on operating costs and crop sales than others. It appears that sugar beets, alfalfa, and rice had the largest impacts per acre fallowed while pasture had the least.

Mitigation of Socioeconomic Impacts of Fallowing Programs

The University of California and Rand Corporation research indicates that the best way to minimize source area adverse impacts is to reduce the actions that cause the problem. Options could include avoiding fallowing crops that require high input and output expenditures, such as sugar beets. Another strategy could include limiting the acreage (either total or crop-specific) fallowed in a specific region. A third potential strategy (with potentially high administrative costs) is to rotate acreage to increase the likelihood of on-farm investment.

A key issue is whether or not there is an actual need to mitigate for adverse economic impacts caused or induced by water transfers. There is no requirement, and limited precedent, for government to mitigate such impacts. The USDA Farm Program, for example, fallows hundreds of thousands of acres each year in California (estimated at 700,000 acres in 1991), without any mention by either the federal government or local communities of the adverse economic impacts to the local community. The national PIK (payment-in-kind) program in the early 1980s fallowed much more than in recent years, and no provisions were made for impacts to local government from significant reductions in farm production. A low-interest loan program was made available for local businesses potentially affected by the PIK program, but generally proved to be ineffective and unworkable. Some have suggested that impacts to local government from water transfers should be mitigated, while impacts to local businesses should be minimized.

Strategies for dealing with third-party economic impacts are being considered by others in dealing with water transfers. For example, a February 1993 report[10] issued

9 Rand. 1993. *California's 1991 Drought Water Bank, Economic Impacts in Selling Regions.* Santa Monica, CA.

10 D.L. Mitchell, 1993. *Water Marketing in California: Resolving Third-Party Impact Issues.* Bay Area Economic Team and Metropolitan Water District of Southern California. Foster Economics, San Francisco.

by the Bay Area Economic Forum and Metropolitan Water District of Southern California contains discussions of potential third-party economic impacts in selling areas and in purchasing areas. The overall conclusion in that report is that adverse impacts in selling areas are not likely to be great but that potential mitigation measures should be explored in more detail.

The report suggested four general mitigation strategies. The first strategy would compensate local governments for any increased demand for services resulting from labor displacement. The second strategy would compensate workers displaced by specific transfers, through such actions as augmenting unemployment insurance benefits, providing job referral and placement services, and job retraining. The third suggested strategy would promote geographically broad-based water transfers and ensure that no one area is involved in a disproportionately large amount of transfer activity. The fourth strategy would promote conjunctive use of ground and surface water resources, which would encourage maintenance of agricultural production in selling regions without adversely impacting groundwater resources.

The report stated that "...in 1991, California farmers voluntarily fallowed over 700,000 acres of land planted to cotton, rice, wheat and other grains in exchange for payments from federal price support programs." The report went on to conclude that "...acreage fallowed to participate in 1991 federal commodity programs was four-and-one-half times greater than that necessary to transfer 500,000 AF to urban uses." The intent of this portion of the report was to contrast an apparent lack of third-party impacts concerns with the federal crop commodity programs as compared to the widespread attention to water transfers.

Additional strategies are being considered in developing a policy for potential future drought water banks. These potential strategies are based on the premise that estimated incremental adverse economic impacts to local government should be reimbursed or avoided in the first place, while other potential economic impacts will be reduced or avoided through recommended actions.

It may be possible to set a fixed price per acre payable to county governments to compensate for potential unemployment costs associated with fallowed land. This should be based on documented cost data from programs such as unemployment, AFDC, and general assistance for each county based on the amount of land actually taken out of agricultural production.

In areas where there is a common water supplier such as a water district, Water Code Section 1745.05 restricts the amount of water made available by land fallowing to 20 percent of the water that would have been applied or stored by the water supplier in the absence of transfers, unless the water supplier approves a larger percentage after providing reasonable notice and conducting a public hearing. The Central Valley Project Improvement Act (PL 102-575) contains a parallel requirement. Another approach is to select different regions for each crop, based on regional support industries, labor and markets. It may be premature to develop a specific policy along these lines without further study into crop commodity markets, regional crop production and other local economic factors.

The complexity of the third-party impact issues would probably make it necessary to develop a reactive strategy to mitigate or reduce specific local adverse economic impacts as they are identified during water transfers. This strategy would need to

consider problems identified in recent research (such as increased unemployment), while developing recommendations for a long-term mitigation strategy. An efficient program to minimize or mitigate confirmed adverse third-party impacts will be a key consideration in limiting the future transaction costs of water transfers associated with fallowing.

Alternative 4
Increased Water Conservation and Demand Reduction Activities

Improving efficiency in use of existing water supplies can reduce the need for water that might be obtained through a water transfer. Greater efficiency can be achieved through improved urban water management, agricultural water management, and water recycling. Water shortage contingency measures are another way water users can reduce impacts. Many urban water suppliers have already proposed water shortage contingency plans that are incorporated into urban water management plans as a requirement to participate in the Drought Water Bank program[11]. Water conservation and demand reduction activities are projected to save up to 1 million acre-feet of water annually by the year 2020. Within the next 6 years, however, implementing water conservation activities that would provide an amount of water available for transfer comparable to that provided under the preferred alternative (400,000 acre-feet) is not believed to be economically or logistically feasible.

Urban Water Management

Water agencies and public advocacy groups in California have worked together to establish an industry standard for urban water management. These organizations identified a series of management measures, called best management practices, that are either established and generally accepted practices or measures that are technically and economically reasonable and environmentally and socially acceptable. A Memorandum of Understanding Regarding Urban Water Conservation in California[12] described 16 best management practices. The MOU also defined a level of effort for implementation of each best management practice and established a timeline calling for implementation of specified practices to commence by 1994, with all practices to be fully implemented throughout the suppliers' service areas by 2001. Many urban areas have implemented a number of these best management practices in recent years. Finally, the MOU calls for the study of certain potential practices that may be added to the list of best management practices in the future.

Pursuant to the California Water Code, every urban water supplier providing water for municipal use either directly or indirectly to more than 3,000 customers or normally supplying more than 3,000 acre-feet of water annually must prepare an urban water management plan containing specified elements and update the plan at least once every 5 years.

11 Department of Water Resources, 1993. *State Drought Water Bank.* Program Environmental Impact Report. 210 pages plus appendixes.
12 Department of Water Resources. 1991. *Memorandum of Understanding Regarding Urban Water Conservation in California.* Also, California Water Code Section 10631(b), paragraph 2.

URBAN BEST MANAGEMENT PRACTICES

- ✓ Interior and exterior water audits and incentive programs for single- and multi-family residential, and governmental/ institutional customers.
- ✓ Plumbing (new and retrofit): enforcing water conserving plumbing fixture standards including ultra-low-flush toilets in new construction beginning January 1, 1992; supporting legislation prohibiting sale of toilets that use more than 1.6 gallons per flush; retrofitting plumbing.
- ✓ Distribution system water audits, leak detection, and repair.
- ✓ Metering, with commodity rates for all new connections and retrofit of existing connections.
- ✓ Large landscape water audits and incentives.
- ✓ Landscape water conservation requirements for new and existing commercial, industrial, institutional, governmental, and multi-family developments.
- ✓ Public information.
- ✓ School education.
- ✓ Commercial and industrial water conservation.
- ✓ New commercial and industrial water use review.
- ✓ Conservation pricing.
- ✓ Landscape water conservation for new and existing single-family homes.
- ✓ Water waste prohibition.
- ✓ Water conservation coordinator.
- ✓ Financial incentives.
- ✓ Ultra-low-flush toilet replacement.

Many urban water agencies have demonstrated commitment to conservation by signing the memorandum of understanding and integrating conservation into their water resource strategies. For example, through its integrated resources planning process, Metropolitan Water District of Southern California and its member agencies have identified a "preferred resource mix". Resource targets for water conservation, local, and imported water supplies are established. Based on the preferred resource mix, an additional 130,000 acre-feet of conservation savings is targeted for the year 2000, representing a 35 percent increase over current levels. By 2020, the target for additional conservation savings is about 512,000 acre-feet, a 138 percent improvement over current levels.

As a regional wholesaler of supplemental water to Southern California, Metropolitan Water District relies on marketing and financial incentives to help its member agencies implement water conservation programs. The cornerstone of those programs — the Conservation Credits Program — provides a financial incentive to any participating local water agency implementing proven water conservation measures. Under the Conservation Credits Program, Metropolitan Water District pays either half the program cost or the equivalent of $154 per acre-foot of water saved. Since its inception in 1988, the Conservation Credits Program has provided $60 million in assistance to participating agencies. During fiscal year 1994 alone, Metropolitan Water District dedicated $19 million for Conservation Credits Program payments.

In addition to economic and financial incentives to encourage water conservation in the Metropolitan Water District service area, other major components of its conservation program include:

- Active participation in the evolving statewide implementation of best management practices.
- Water conservation research and development to define the reliable yield from existing conservation programs, to improve the design and targeting of future programs, and to hasten the development of new conservation technologies and measures.
- Public information and education to teach and encourage the community to use water efficiently. For example, the Metropolitan Water District publications *Aqueduct 2000* and *Top Ten Tips for*

Saving Water are designed to encourage consumers to integrate water conservation measures into their daily lives. Educational programs include school curricula, teachers' seminars, and business partnerships.

Although conservation activities could potentially be increased throughout the State Water Project service area, service-area-wide conservation program cost data are not readily available. Therefore, a proxy for the potential costs of increasing conservation by 400,000 acre-feet annually was developed using conservation program cost and retail demand data for Metropolitan Water District's service area.

The costs associated with two alternative approaches to reduce water demand by 400,000 acre-feet were examined. Under the first approach, the schedule of regional conservation targets established by Metropolitan Water District's Integrated Resources Plan (IRP) would be accelerated to increase 1997 planned regional conservation by an additional 400,000 acre-feet. Under the second approach, existing conservation programs would be maintained at planned levels and 1997-2001 regional water demand would be reduced by 400,000 acre-feet through price rationing. The estimated cost of each alternative is described below.

Approach 1: Accelerated Schedule of IRP Conservation Targets

Conservation targets for Metropolitan Water District's service area, as established by the preferred resources mix of the Integrated Resources Plan, are shown in Table 10. The table also indicates how these targets would have to be adjusted to produce an additional 400,000 acre-feet of water conservation by 1997. The region would be required to meet year 2010 conservation targets by 1997, 13 years sooner than established by the region's preferred resources mix.

The *net* cost to the region of accelerating the IRP conservation schedule is the cost difference of meeting the two alternative schedules. For this analysis, it was assumed that conservation targets would be met through aggressive implementation of residential and commercial ULFT retrofit programs and residential water audits. Cost and water savings data for these programs, shown in Table 11, are based on the most recent conservation program evaluations performed for Metropolitan Water District's service area.[13]

The regional cost of implementing each schedule was estimated using the data in Table 11 and selecting a program implementation sequence that minimized the present-value cost of meeting the regional conservation targets. The preliminary estimate of remaining conservation potential for ULFT and residential audit programs is somewhat less than 400,000 acre-feet. It was assumed that this remaining increment of water could be produced at the same cost per acre-foot as residential water audits.

Results of the cost analysis are shown in Table 12. For each conservation implementation schedule, the table shows the annual costs of meeting each year's target as well as the total present value cost of meeting the schedule, assuming a 6.5% discount rate. As shown by the last line of Table 12, the regional cost of accelerating the schedule of IRP conservation targets to conserve an additional 400,000 acre-feet of water by 1997 is conservatively estimated to be just over $1 billion.

13 A&N Technical Services. 1994. *The 1992 City of San Diego Residential Water Audit Program: Evaluation of Program Outcomes and Water Savings, Final Report.*

Table 10
METROPOLITAN WATER DISTRICT IRP CONSERVATION TARGETS
Accelerated to Reduce 1997 Demand by 400,000 Acre-Feet
(in thousand acre-feet)

Target Year	IRP Conservation Target	Increase over Prior Year	Accelerated IRP Conservation Target	Increase over Prior Year
1995	96		96	
1996	103	7	103	7
1997	110	7	510	407
1998	117	7	510	0
1999	123	7	510	0
2000	130	7	510	0
2001	158	38	510	0
2002	206	38	510	0
2003	245	38	510	0
2004	283	38	510	0
2005	321	38	510	0
2006	359	38	510	0
2007	397	38	510	0
2008	436	38	510	0
2009	474	38	510	0
2010	512	38	512	2

Bold = IRP conservation targets.
Italic = Linearly extrapolated IRP conservation targets.
SOURCE: Metropolitan Water District. 1995. *Regional Urban Water Management Plan for the* Metropolitan Water District of Southern California.

Table 11
COSTS AND SAVINGS FOR
METROPOLITAN WATER DISTRICT CONSERVATION PROGRAM

	Remaining Active Conservation Potential (AF/year) [1]	Savings per Device (AF/year) [2]	Cost per Device (dollars) [3]	Annualized Cost/AF (dollars) [4]
Commercial ULFT	68,000	0.082	275	193
Multi-Family ULFT	56,000	0.045	175	224
Single-Family ULFT	87,000	0.024	205	490
Residential Water Audit [5]	182,000	0.020	46	500

Total Potential = 393,000 acre-feet per year
Average Cost = $405 per acre-foot.

1 Preliminary MWD-Main forecasts. These estimates are subject to change. Residential Water Audit savings are extrapolated from MWD-Main forecasts of remaining showerhead replacement. Estimates are "net" of savings from local ordinances.
2 ULFT savings and residential water audit program savings were estimated by A&N Technical Services for Metropolitan Water District.
3 ULFT program costs were estimated by A&N Technical Services for Metropolitan Water District.
4 Levelized program costs per acre-foot per year, including interest, divided by the program life span. Estimated by A&N Technical Services for Metropolitan Water District.
5 The high cost per acre-foot of residential audits given the low unit cost is explained by the relatively short persistence of savings (assumed to be 5 years).

Table 12
PRESENT-VALUE COST OF ACCELERATING THE IRP SCHEDULE
Annual Capital Outlay (million dollars)

Target Year	IRP Target	Accelerated Target
1996	1	1
1997	3	170
1998	4	170
1999	5	170
2000	7	170
2001	14	170
2002	23	170
2003	38	170
2004	56	170
2005	75	170
2006	94	170
2007	113	170
2008	132	170
2009	152	170
2010	171	171
Present-Value Cost	450	1,532
Net Present-Value Cost		1,083
Discount Rate = 6.5%		

It is important to note that this is a lower-bound estimate. The actual cost of accelerating the IRP conservation target schedule is expected to be substantially higher for the following reasons:

- The analysis assumes identical implementation costs for both schedules and only measures the present-value cost of not deferring the conservation investments. In fact, accelerating the schedule of IRP conservation targets to the degree contemplated by the analysis would be expected to result in significantly higher labor and capital costs. For example, while Metropolitan Water District ULFT programs have installed nearly 1 million ULFTs since 1988, the accelerated schedule would require installation of an additional 5.7 million ULFTs by 1997. An increase in demand for ULFTs of this magnitude is sure to affect prices.

- The analysis assumes that both the original and the accelerated IRP conservation targets would be met only through "active" conservation programs. However, in developing the original IRP conservation targets, Metropolitan Water District assumed that they would be met through a combination of "passive" and "active" conservation.[14] In general, passive conservation is substantially less expensive than active conservation. Since passive conservation depends on the pace of new construction and remodeling, it could not be relied on to meet the accelerated IRP conservation targets.

- The analysis does not account for diminishing returns to conservation but, rather, assumes that per-unit water savings are constant regardless of program scale. In fact, existing ULFT and showerhead retrofit programs in the Metropolitan Water District service area have already demonstrated diminishing returns.[15] Increasing the scale of these programs, particularly in the residential sector, is likely to accelerate this trend. Diminishing returns under the accelerated schedule is likely to be much more pronounced than under the original schedule, since the benefits of new water-saving technologies and programs — such as horizontal axis washing machines — that are still several years away from implementation would not be realized.

Taken together, the above factors would most likely result in substantially higher program costs for the case of an accelerated implementation schedule than assumed by the analysis.

14 "Passive" conservation refers to conservation savings resulting from municipal and state ordinances regulating the types of water-using fixtures that can be sold and/or used in a given region. An example is prohibition of the sale of toilets with flush volumes exceeding 1.6 gallons.

15 A&N Technical Services. 1994. *Ultra Low Flush Toilet Programs: Evaluation of Program Outcomes and Water Savings.* Final Report.

Approach 2: Price-Rationing to Reduce Demand by 400,000 Acre-Feet

Accelerating the schedule of IRP conservation targets to decrease 1997 water demand by 400,000 acre-feet is likely to be logistically infeasible. If this is the case, demand would have to be rationed to produce the requisite water savings. The most expedient way to do this would be through price rationing, whereby retail water prices would be increased to a level sufficient to reduce regional demand by 400,000 acre-feet.

The regional cost of price rationing demand would be the change in "consumer surplus" resulting from the price change. Consumer surplus measures the difference between what consumers would be willing to pay for a given level of goods or services, as described by the market demand curve, versus what they actually pay, as determined by the market clearing price.[16] Consumer surplus is a standard measure for changes in consumer welfare resulting from a price change.[17]

To approximate the consumer surplus loss, a simple model of regional demand was developed. Using this model, the "choke price" — the price necessary to reduce demand by 400,000 acre-feet — and the resultant consumer surplus loss were derived.

Linear demand functions were used to model the relationship between price and demand. A linear form was chosen to allow demand elasticity to increase as water becomes more expensive. In other words, consumer demands were modeled as becoming more flexible as water becomes more expensive. This behavioral response is consistent with empirical studies of water demand.[18]

Parameters for the demand model were developed from price and demand data for the Metropolitan Water District service area contained in its most recent regional urban water management plan.[19] Because changes in consumer surplus are sensitive to the elasticity of demand and because estimates of demand elasticity for Metropolitan's service area vary, the consumer surplus loss was approximated for low-, expected- and high-demand elasticity. Expected-demand elasticity is based on recent empirical studies of Metropolitan service area water demand, as reported in Chapter IV of the Regional Urban Water Management Plan. The low and high elasticities serve as lower and upper bounds for the expected estimate and are consistent with empirical estimates of urban water demand in California.[20]

Results of the analysis are shown in Table 13.

Table 13
CONSUMER SURPLUS LOSSES ASSOCIATED WITH PRICE RATIONING TO CONSERVE AN ADDITIONAL 400,000 ACRE-FEET IN THE MWD SERVICE AREA

Demand Elasticity	Elasticity Value	PV Lost Consumer Surplus (million $)
Low	0.075	6,300
Expected	0.150	2,600
High	0.300	1,700

16 Algebraically, consumer surplus is the area under the demand curve to the left of the quantity demanded and above the price line.
17 R. Willig. 1976. Consumer's Surplus Without Apology. *American Economic Review* 68:589-597.
18 D.L. Mitchell and W.M. Hanermann. 1994. *Setting Urban Water Rates for Efficiency and Conservation: A Discussion of Issues.* California Urban Water Conservation Council.
19 Metropolitan Water District of Southern California. 1995. *The Regional Urban Water Management Plan for the Metropolitan Water District of Southern California.*
20 D.L. Mitchell and W.M. Hanermann. 1994. *Setting Urban Water Rates for Efficiency and Conservation: A Discussion of Issues. California Urban Water Conservation Council.*

Agricultural Water Management

An advisory committee composed of representatives of irrigation districts, public interest groups, and others is working to establish a process to implement agricultural efficient water management practices. Formation of this advisory committee was authorized by the Agricultural Water Suppliers Efficient Water Management Practices Act of 1990.[21] The committee has drafted a list of efficient water management practices and has almost completed a Memorandum of Understanding for their implementation. The final Memorandum of Understanding will be circulated for signature during November and December 1996.

The Department of Water Resources recommends these practices as the standard for efficient agricultural water management.

MEMORANDUM OF UNDERSTANDING REGARDING EFFICIENT WATER MANAGEMENT PRACTICES FOR WATER SUPPLIERS IN CALIFORNIA

List A

- ✓ Prepare and adopt a water management plan.
- ✓ Designate a water conservation coordinator.
- ✓ Support the availability of water management services to water users.
- ✓ Improve communication and cooperation among water suppliers, water users, and other agencies.
- ✓ Evaluate the need, if any, for changes in policies of the institutions to which the water supplier is subject.
- ✓ Evaluate and improve efficiencies of water suppliers plans.

List B

- ✓ Facilitate alternative land use.
- ✓ Facilitate use of available recycled water.
- ✓ Facilitate the financing of capital improvements for on-farm irrigation systems.
- ✓ Facilitate voluntary water transfers.
- ✓ Line or pipe ditches and canals.
- ✓ Increase flexibility in water ordering.
- ✓ Construct and operate water supplier spill and tailwater recovery systems.
- ✓ Optimize conjunctive use.
- ✓ Automate canal structures.

List C

- ✓ Water measurement and water use report.
- ✓ Pricing and other incentives.

21 Water Code Section 10900 *et seq.*

REQUIRED ELEMENTS OF WATER SHORTAGE CONTINGENCY PLANS

- ✓ Coordination of plan preparation with other urban water suppliers and public agencies in the area.
- ✓ Past, current, and projected water use, by sector.
- ✓ Estimate of the minimum water supply available at the end of 12, 24, and 36 months assuming worst-case water supply shortages.
- ✓ Stages of action to be undertaken in response to water supply shortages as severe as 50 percent and an outline of conditions applicable to each stage.
- ✓ Mandatory provisions to reduce water use, such as prohibitions against gutter flooding.
- ✓ Consumption limits in the most restrictive stages of the plan, such as percentage reductions or per-capita allotments.
- ✓ Penalties or charges for excessive use.
- ✓ Analysis of the impacts of the plan on revenues and expenditures of the water supplier.
- ✓ Draft ordinance or resolution to carry out the plan.
- ✓ Mechanism for determining actual reductions in water use.
- ✓ Public notices and adoption of the plan.

Water Shortage Contingency Planning

Implementation of best management practices would reduce long-term per capita water demand in urban areas. Urban water suppliers also need more planning and coordination during occasional water supply shortages such as droughts. Pursuant to the California Water Code, Section 10631(e), any water supplier providing water for municipal use either directly or indirectly to more than 3,000 customers or normally supplying more than 3,000 acre-feet of water annually must prepare a water shortage contingency plan before it is eligible to receive any drought assistance from the State. Agencies that are too small to meet these size criteria are encouraged to carry out such planning but will not be required to do so.

Water Recycling

Disinfected tertiary treated recycled water can be used for all but potable applications. For example it can be used to irrigate parks, school yards, playgrounds, and food crops where reclaimed water contacts the edible portion of the crop (including all root crops); for toilet flushing in nonresidential buildings; and for some groundwater recharge.

More treated municipal waste water is now produced in California than is being reclaimed and reused, but water recycling is increasing. More than 1.5 million acre-feet of treated waste water is discharged to the ocean every year. In 1985, about 250,000 acre-feet was recycled. By 1995, 370,000 acre-feet was recycled. By 2010, under favorable conditions, statewide use of recycled water could exceed 1.3 million acre-feet according to a 1996 survey of water recycling potential conducted by the Department of Water Resources and the WateReuse Association of California. The greatest incentives for expanded reuse occur where communities experience unreliable water supplies, treated waste water discharge is limited by regulation, potable water supplies are fully used, or potable water is expensive.

Reuse sites are not always near treatment facilities. Therefore, distribution facility costs are often greater than treatment plant capacity. Moreover, many recycled water uses are seasonal and, thus, to justify projects, storage facilities must be considered. This increases costs in such cases.

In some communities, such as those in Orange County and parts of Los Angeles, recycled water is used to recharge drinking water aquifers and is ultimately potably reused. In some cases, like Orange County, where the recycled water is injected directly into the aquifer, additional advanced tertiary treatment is required. The City of San Diego has been approved by the Department of Health Services to develop an

advanced tertiary reclaimed water project that will augment a raw surface water reservoir upstream from the drinking water treatment facility. In San Diego's case, this potable reuse makes economic sense because of all the reasons stated above. In addition, San Diego citizens appear to accept the concept of drinking recycled water.

A Statement of Support for Recycled Water was signed in June 1994 by leaders of the Department of Water Resources, Department of Health Services, State Water Resources Control Board, U.S. Environmental Protection Agency, U.S. Bureau of Reclamation, California Conference of Directors of Environmental Health, and the WateReuse Association, committing those agencies to promote the safe and reliable uses of recycled water.

The Memorandum of Understanding Regarding Urban Water Conservation in California recognizes that urban water suppliers should prepare feasibility studies on water reclamation for their respective service areas. The California Urban Water Agencies has begun working with the WateReuse Association to establish a framework and guidance for water suppliers to use for this purpose. In addition, 1991 amendments to the Water Code (AB 1869) describe information on reclamation that should be included in urban and agricultural water management plans.

Potential Environmental Impacts of Increasing Water Conservation

Water reclamation and reuse such as advanced treatment of domestic waste water can result in diminished streamflow, lost riparian habitat, decreased wetland acreage, and problems with water quality. In situations where this causes significant impacts, it may be necessary to mitigate by using a portion of the reclaimed water for fish and wildlife management.

Although difficult to quantify, water conservation in agricultural situations has the greatest potential to adversely impact various kinds of fish and wildlife. Tailwater often supports small wetlands or pockets of riparian vegetation. These small areas receive disproportionately more wildlife use than the surrounding agricultural areas. In areas where agricultural water conservation is highly developed, especially where irrigation water is delivered via covered ditches or in pipes, tailwater is an important source of wildlife drinking water. Reductions in drainage flows through reuse on fields can diminish instream flows and inflow to sinks and sumps that may be important fish and wildlife habitat. Lining ditches, covering ditches, and piping water to fields can reduce annual and perennial vegetation along streambanks, with resultant losses in wildlife food, cover, and nesting habitat.

Moderation may be important to minimizing wildlife impacts associated with agricultural water conservation. Short-term, moderate-scale conservation may not generate significant adverse impacts. However, long-term or permanent reduction of water available to wildlife due to conservation may require mitigation. The most obvious mitigation technique is to allocate part of the conserved water for managing fish and wildlife habitat.

Urban wildlife habitats are often overlooked, but they can be important refuges for many species. Storage basins for runoff, drainage facilities, recharge basins, and sewage treatment plants all serve a role in maintaining urban wildlife. Water conservation may also decrease the availability of wildlife habitat from these sources.

Alternative Water Production Methods Reviewed and Determined Infeasible in the Immediate Future

The Department of Water Resources has previously reviewed several innovative water supply proposals that could increase the overall availability of water for the State Water Project. Examples are Delta island flooding, rice wetlands projects, desalination, and weather modification. Studies or pilot programs have been conducted for all of these methods, but results have been generally inconclusive with regard to widespread applicability, except that all are not economically viable within a short-term planning horizon. The total amount of water that could be made available by each method would be directly related to the magnitude of effort expended for each — that is, the amount of land and/or money allocated to each method on a statewide or regional basis. At this time, none of the projects discussed below is expected to be on line during the 6-year term of the proposed Supplemental Water Purchase Program. Therefore, they were found to be not viable for meeting the goals of the proposed program, and no further in-depth analysis of these alternative is presented.

Delta Island Flooding

Flooding Delta islands has been proposed to store winter/spring diversions of unappropriated surface water. These islands would function as reservoirs for later water transfers and as waterfowl habitat. Increased availability of water and the extent and wildlife value of wetland habitats are potential benefits of this alternative. In addition, island flooding could provide greater operational flexibility for meeting export demands and Delta outflow requirements by capturing winter flows and releasing the water in the summer.

To store water on lowland Delta islands, large siphons would be used to divert water onto the islands in the winter. The water would be pumped out in the spring and sold to the State Water Project, Central Valley Project, or others. The timing and volume of diversions would depend on availability of unregulated surplus Delta outflow as defined by Decision 1485. Surplus Delta outflows are assumed to begin in January when rainfall typically produces significant excess runoff into the Delta. Surplus water could be diverted in January through May and discharged in May through July. The discharged water would mix with inflows from the Sacramento River and other tributaries. This water could then be pumped by the State Water Project or Central Valley Project.

From August through December, islands would be exposed and could be farmed or revegetated with wetland plants useful to wintering waterfowl as forage or cover. Islands with riparian water rights could be flooded to a shallow depth from October through December to attract wintering waterfowl. These waterfowl benefits would partially offset the extreme reduction in wetlands and riparian habitats in California, which supports the restoration and enhancement value of this proposal.

Flooding Delta islands could provide benefits such as increased water storage, increased availability of low-salinity water for the Delta, greater operational flexibility, and increased extent and value of wetland habitat, but several technical issues must be resolved to make it workable. These include water rights, seepage onto adjacent

islands, fish screens, channel flow patterns, water quality, levee stability, and fish and wildlife impacts.

A draft EIS/EIR on the proposed Delta Wetlands Project thoroughly describes and evaluates the effects of island flooding.[22]

Rice Wetlands Project

In early 1992, a partnership of The Nature Conservancy, California Rice Industry Association, California Waterfowl Association, and Ducks Unlimited was created as a result of legislation requiring rice growers to reduce burning rice stubble. The partnership was formed to investigate the feasibility of:

- Providing additional habitat for migrating waterfowl.
- Decomposing rice straw.
- Storing water.

This third component could provide some water transfer benefits.

Most rice farming in the Sacramento Valley is irrigated with surface water. On a number of farms, however, wells used before surface supplies were developed could provide part of the water needed for the rice wetlands project. During early fall, when streamflows are low and water is being released from reservoirs, groundwater could be used for flooding fields to conserve reservoir supplies for transfers. After the rains begin and excess flows are available, stream diversions could resume. Some of the excess winter flow could be stored on the fields for release in the spring, when diversion demands are typically high.

Water supply benefits of the project would increase as the water was held later in the spring. Under current typical farming operations, the field would be drained by mid-March. Excess flows generally occur in March, so draining the fields at that time would not add to supply. Rice must generally be planted by the first of May for fall harvest, and the land must dry for a couple of weeks after water is removed to be tillable. Therefore, to develop increased firm yield, benefits would accrue only if the water were held until mid-April or May, when demands for water from the river become greatest.

Changes in farming operations may allow the ponded water to be held until late-April or May. The ponded water could be collected in March and stored on a portion of the farm. The dewatered part could be tilled and planted in rice. The water storage portion could be drained back to the tilled field preparatory to planting rice, resulting in direct water savings by not diverting from the river. The ponded area last drained could be planted in a later crop such as dry beans, late corn, or green tomatoes.

22 Jones and Stokes Associates, 1995. *Draft Environmental Impact Report and Environmental Impact Statement for the Delta Wetlands Project.* Prepared for California State Water Resources Control Board, Division of Water Rights, and U.S. Army Corps of Engineers, Sacramento District. JSA 87-119. Sacramento.

The principal environmental impact of winter-flooding rice fields involves the potential diversion and loss of young fish, especially winter-run chinook salmon. If fish loss can be prevented through screening, the temporarily flooded land could benefit wetland-dependent wildlife.

Waterfowl would benefit from waste grain, weed seeds, and invertebrates that would be made accessible if temporary flooding or storage projects limit water depth at peak storage to no more than 2 feet. Stored water could be returned to the rivers or the Delta on an as-needed basis without significant consequence to wildlife habitat.

Water quality concerns include the release of water high in organic content, which favors the formation of trihalomethanes in the Delta. Water applied to fields also may absorb toxic chemicals applied to control weeds and vertebrate pests. Water laden with toxins could have significant adverse impacts on fish and other aquatic life in streams where the water was discharged. Large expanses of shallow water will warm readily during spring days. Temperatures of released water may be significantly higher than receiving water, which could also impact aquatic life.

Although there appears to be a potential for water storage benefits, the program is not now being investigated because of conflicts with farming operations and what appears to be initial high costs.

Desalination

Water reclaimed through desalination offers potential to expand California's water supply. Years of drought and the increased expense of developing new sources of imported water have prompted interest in finding an economical way to remove salt from ocean and brackish groundwater. Modern desalination methods make it possible to generate large volumes of water of suitable purity. In some parts of the world, desalting is an important source of water. In 3,500 plants worldwide, desalting capacity is about 3 billion gallons per day. In the United States, about 750 desalting plants have a combined capacity of 212 million gallons per day. In California, desalting is used to reclaim brackish groundwater, desalt sea water, and treat water for industries that require high purity water for processing.[23] It may be possible to develop a program of desalting brackish agricultural drainage water to allow further local reuse of that water as a substitute for water imported from the Delta, primarily for agriculture, since the quality does not have to be as high as for drinking water.

The principal limitation of desalination is the high cost due to the high energy requirements (40 to 60 percent of the operating costs). California's brackish groundwater basins have not been developed because of the high cost of desalination compared to the costs of alternative sources. As conventional water sources become more difficult and expensive to develop and desalination methods become more efficient, the cost of desalination will become more competitive.

The cost of desalination varies depending on the quality of water being treated. Raw water delivered to a desalination plant in California or elsewhere may be either sea water, brackish water, or waste water. With few exceptions, sea water has a constant

23 Department of Water Resources. 1991. *Overview of Desalting in California.* Memorandum Report, Division of Planning, Sacramento.

composition throughout the world and contains 35,100 mg/L of total dissolved solids and can be desalted at a cost of $1,200 to $3,000 per acre-foot. Brackish water, generally defined as having no more than 5,000 mg/L of dissolved impurities, can be desalted for about $300 to $500 per acre-foot. Waste water, available from a variety of sources, has varied concentrations of impurities; costs for desalination run from $400 to $3,000 per acre foot, depending on the quality of the waste water.

In addition to the high energy cost, other costs of desalting water result from problems associated with the quality of the source water, pretreatment requirements, scale formation, storing and handling potentially dangerous chemicals, storing brine concentrate, and a reduction in the purity of product water related to age of the plant. Blending product water with untreated water could reduce these costs. For example, if a well with 2,000 mg/L total dissolved solids was blended with product water with 10 mg/L TDS, water with 500 mg/L TDS may be achieved at a 25 percent reduction in cost.[24]

Potential benefits to desalination and other water purification processes include protecting water quality, cleaning up groundwater, and resolving problems posed by pollutants and contaminants. Agricultural, municipal, and industrial effluent are reliable sources of water that could be reclaimed, and desalting either groundwater or waste water is less costly than desalting sea water. Benefits of restoring the quality of otherwise unusable water include restoration of abandoned aquifers and closed wells, enhancement of recharge operations, and provision of additional flow to protect against sea water intrusion.

The City of Santa Barbara has a prototype plant capable of producing 7,500 acre-feet per year. Beginning in February 1992, during a local drought, the plant operated 60 days then went on indefinite standby when an adequate water supply was restored. The price of water produced was $1,925 per acre-foot. The facility can be expanded to a capacity of 10,000 acre-feet per year. The plant was developed in consultation with the Department of Fish and Game to avoid significant environmental impacts, and no associated wildlife impacts were identified.

Use of desalination to supplement water supplies will likely continue to expand as conventional water supplies become more expensive and desalination becomes less expensive. Also, fresh water obtained from desalting can be tailored to meet the needs of many nondomestic uses.

A few desalination plants are operational and others are in the planning stages, but their capacity is inadequate and the ability to transport product water to areas of need is still lacking. Major water supply benefits are not expected in the near term from desalination projects, mainly because of the overall high costs.

Disposal of waste products from large-scale desalination is a major environmental concern. Some desalination techniques use toxic chemicals that must be handled and disposed to appropriate sites. All desalination creates concentrated brines that contain high levels of dissolved solids and toxic substances such as heavy metals. Application to land can contaminate groundwater as concentrated brines infiltrate the soils.

24 Bechtel Group, Inc., 1983. *Desalination Technology, Report on the State of the Art.* San Francisco.

Holding ponds for the brines attract waterfowl and other wildlife, and toxic compounds in the ponds can result in reproductive deformities or even death.

Sea water desalination is not generally believed to cause significant wildlife impacts except, possibly, habitat loss at the plant location, which should be selected with the goal of avoiding sensitive areas. Aquatic organisms, including small fish or eggs, could be entrained at the pumps leading to a desalination plant. Careful design and maintenance of screens is necessary to minimize such losses.

Agricultural drainage water desalination could result in wildlife impacts. In the San Joaquin Valley, drainage water too saline for agricultural use contributes to maintenance of wetland habitat used by migratory birds. Reducing the volume of brackish water available to wildlife habitats or increasing salinity or contaminants could impact wildlife. Brine generated by desalting agricultural waste water could contain high levels of toxic materials that, unless properly disposed of, would threaten wildlife. Each individual project must be carefully evaluated, mitigated if necessary, and monitored.

Weather Modification

The amount of rain and snow derived from clouds with the right moisture and temperature characteristics can be increased by weather modification techniques. Many investigators believe that average annual precipitation might be increased by about 10 percent. Such techniques have been used along the western slopes of the Sierra Nevada and some of the Coast Ranges for several years. However, precipitation will increase only when storm clouds are present, so the technique is most successful in years of near-normal rainfall.

In 1985, the Department of Water Resources awarded a contract to North American Weather Consultants to conduct a feasibility study of cloud seeding in the Feather River watershed. Results led to funding an operational plan and preparation of environmental documentation for the Lake Oroville Runoff Enhancement Program. The program emphasizes augmenting streamflow by increasing snowpack in 1991. That program began cloud seeding with liquid propane on an experimental basis at 10 sites in the winter of 1992/93 and continuing for 3 consecutive winters. However, testing was hindered by abnormal weather conditions that were either too dry or too wet in all years. Data collected were statistically inadequate for reliable results but indicated an average snowpack augmentation of about 5 percent above normal.

A 1993 U.S. Bureau of Reclamation feasibility study for a cloud seeding program in the watersheds above Shasta and Trinity dams indicated good potential for the Trinity River Basin, but the study cast doubt about the effectiveness of a project for Shasta Lake. The Bureau of Reclamation has done substantial cloud seeding research in the Colorado River Basin. In September 1993, the Bureau published Validation of Precipitation Management by Seeding Winter Orographic Clouds in the Colorado River Basin. However, the Bureau is phasing out its participation in weather modification projects.

Interest remains high in using cloud seeding to provide both short-term and long-term drought relief. The technique is more successful in near-normal years, when more moisture in the form of storm clouds is present to be treated. It is also more effective

when combined with carryover storage to take full advantage of additional precipitation and runoff.

This program has been discontinued as a result of U.S. Forest Service restrictions and concerns raised by local public works departments with regard to increased costs for snow removal. Therefore, a weather modification program is not a viable alternative to the proposed Supplemental Water Purchase Program.

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Appendix A

ANNUAL ENTITLEMENTS TO PROJECT WATER

C-091853

Annual Entitlements to Project Water

(Acre-Feet)

Calendar Year	North Bay Area			South Bay Area (a				Central Coastal Area		
	Napa County FC&WCD (b (1)	Solano County Water Agency (2)	Total (3)	Alameda County FC&WCD, Zone 7 (4)	Alameda County Water District (5)	Santa Clara Valley Water District (6)	Total (7)	San Luis Obispo County FC&WCD (8)	Santa Barbara County FC&WCD (9)	Total (10)
1962	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	507	5,248	5,783	11,538	0	0	0
1968	0	0	0	6,900	15,000	88,000	109,900	0	0	0
1969	0	0	0	8,200	15,500	75,000	98,700	0	0	0
1970	0	0	0	10,000	16,200	88,000	114,200	0	0	0
1971	0	0	0	11,200	17,000	88,000	116,200	0	0	0
1972	0	0	0	12,400	17,900	88,000	118,300	0	0	0
1973	0	0	0	13,600	18,800	88,000	120,400	0	0	0
1974	0	0	0	14,800	19,600	88,000	122,400	0	0	0
1975	0	0	0	16,000	20,500	88,000	124,500	0	0	0
1976	0	0	0	17,200	21,300	88,000	126,500	0	0	0
1977	0	0	0	18,400	22,200	88,000	128,600	0	0	0
1978	0	0	0	19,600	23,100	88,000	130,700	0	0	0
1979	0	0	0	20,800	23,900	88,000	132,700	0	0	0
1980	0	500	500	22,000	24,800	88,000	134,800	1,000	946	1,946
1981	0	650	650	23,000	26,000	88,000	137,000	1,000	1,813	2,813
1982	0	800	800	24,000	27,200	88,000	139,200	2,000	3,626	5,626
1983	0	950	950	25,000	28,400	88,000	141,400	3,000	5,439	8,439
1984	0	1,100	1,100	26,000	29,600	88,000	143,600	4,500	8,198	12,698
1985	0	1,250	1,250	27,000	30,800	88,000	145,800	7,500	13,638	21,138
1986	0	1,400	1,400	28,000	32,100	88,000	148,100	10,000	18,210	28,210
1987	0	1,550	1,550	29,000	33,300	88,000	150,300	12,500	22,704	35,204
1988	5,745	9,726	15,471	30,000	34,500	88,000	152,500	15,500	28,222	43,722
1989	6,195	18,420	24,615	31,000	35,700	90,000	156,700	20,000	36,342	56,342
1990	6,940	21,250	28,190	32,000	36,900	92,000	160,900	25,000	45,486	70,486
1991	7,290	22,300	29,590	34,000	38,400	94,000	166,400	25,000	45,486	70,486
1992	7,840	24,170	32,010	36,000	39,900	96,000	171,900	25,000	45,486	70,486
1993	8,490	26,130	34,620	38,000	41,400	98,000	177,400	25,000	45,486	70,486
1994	9,135	28,080	37,215	40,000	42,000	100,000	182,000	25,000	45,486	70,486
1995	9,780	34,250	44,030	42,000	42,000	100,000	184,000	25,000	45,486	70,486
1996	10,425	37,800	48,225	44,000	42,000	100,000	186,000	25,000	45,486	70,486
1997	11,065	38,250	49,315	46,000	42,000	100,000	188,000	25,000	45,486	70,486
1998	11,710	38,710	50,420	46,000	42,000	100,000	188,000	25,000	45,486	70,486
1999	12,330	39,170	51,500	46,000	42,000	100,000	188,000	25,000	45,486	70,486
2000	13,050	39,620	52,670	46,000	42,000	100,000	188,000	25,000	45,486	70,486
2001	13,665	40,080	53,745	46,000	42,000	100,000	188,000	25,000	45,486	70,486
2002	14,185	40,540	54,725	46,000	42,000	100,000	188,000	25,000	45,486	70,486
2003	14,800	41,000	55,800	46,000	42,000	100,000	188,000	25,000	45,486	70,486
2004	15,400	41,450	56,850	46,000	42,000	100,000	188,000	25,000	45,486	70,486
2005	16,000	41,500	57,500	46,000	42,000	100,000	188,000	25,000	45,486	70,486
2006	16,450	41,550	58,000	46,000	42,000	100,000	188,000	25,000	45,486	70,486
2007	17,000	41,600	58,600	46,000	42,000	100,000	188,000	25,000	45,486	70,486
2008	17,650	41,650	59,300	46,000	42,000	100,000	188,000	25,000	45,486	70,486
2009	18,200	41,700	59,900	46,000	42,000	100,000	188,000	25,000	45,486	70,486
2010	18,750	41,750	60,500	46,000	42,000	100,000	188,000	25,000	45,486	70,486
2011	19,400	41,800	61,200	46,000	42,000	100,000	188,000	25,000	45,486	70,486
2012	19,950	41,850	61,800	46,000	42,000	100,000	188,000	25,000	45,486	70,486
2013	20,600	41,900	62,500	46,000	42,000	100,000	188,000	25,000	45,486	70,486
2014	21,250	41,950	63,200	46,000	42,000	100,000	188,000	25,000	45,486	70,486
2015	21,900	42,000	63,900	46,000	42,000	100,000	188,000	25,000	45,486	70,486
2016	22,500	42,000	64,500	46,000	42,000	100,000	188,000	25,000	45,486	70,486
2017	23,100	42,000	65,100	46,000	42,000	100,000	188,000	25,000	45,486	70,486
2018	23,700	42,000	65,700	46,000	42,000	100,000	188,000	25,000	45,486	70,486
2019	24,300	42,000	66,300	46,000	42,000	100,000	188,000	25,000	45,486	70,486
2020	24,900	42,000	66,900	46,000	42,000	100,000	188,000	25,000	45,486	70,486
2021	25,000	42,000	67,000	46,000	42,000	100,000	188,000	25,000	45,486	70,486
2022	25,000	42,000	67,000	46,000	42,000	100,000	188,000	25,000	45,486	70,486
2023	25,000	42,000	67,000	46,000	42,000	100,000	188,000	25,000	45,486	70,486
2024	25,000	42,000	67,000	46,000	42,000	100,000	188,000	25,000	45,486	70,486
2025	25,000	42,000	67,000	46,000	42,000	100,000	188,000	25,000	45,486	70,486
2026	25,000	42,000	67,000	46,000	42,000	100,000	188,000	25,000	45,486	70,486
2027	25,000	42,000	67,000	46,000	42,000	100,000	188,000	25,000	45,486	70,486
2028	25,000	42,000	67,000	46,000	42,000	100,000	188,000	25,000	45,486	70,486
2029	25,000	42,000	67,000	46,000	42,000	100,000	188,000	25,000	45,486	70,486
2030	25,000	42,000	67,000	46,000	42,000	100,000	188,000	25,000	45,486	70,486
2031	25,000	42,000	67,000	46,000	42,000	100,000	188,000	25,000	45,486	70,486
2032	25,000	42,000	67,000	46,000	42,000	100,000	188,000	25,000	45,486	70,486
2033	25,000	42,000	67,000	46,000	42,000	100,000	188,000	25,000	45,486	70,486
2034	25,000	42,000	67,000	46,000	42,000	100,000	188,000	25,000	45,486	70,486
2035	25,000	42,000	67,000	46,000	42,000	100,000	188,000	25,000	45,486	70,486
TOTAL	878,695	1,848,396	2,727,091	2,494,607	2,459,248	6,510,783	11,464,638	1,227,000	2,231,494	3,458,494

a) Entitlements for the South Bay area were supplied by non-Project water for the period June 1962 through November 1967. Actual delivery quantities of Project water are shown for 1967.

b) District's Table A quantities exclude amounts during the period 1968 through 1987 that are assumed to be supplied by non-SWP water

Annual Entitlements to Project Water

(Acre-Feet)

Calendar Year	San Joaquin Valley Area								
			Kern County Water Agency						
	Dudley Ridge Water District (11)	Empire West Side Irrigation District (12)	Municipal and Industrial (13)	Agricultural (14)	Total (15)	County of Kings (16)	Oak Flat Water District (17)	Tulare Lake Basin Water Storage District (18)	Total (19)
1962	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0
1968	14,300	1,000	0	46,600	46,600	900	2,300	12,250	77,350
1969	14,325	3,000	0	95,700	95,700	1,200	2,500	46,350	163,075
1970	15,700	3,000	28,700	116,400	145,100	1,300	2,600	34,300	202,000
1971	17,900	3,000	35,700	154,600	190,300	1,300	2,800	36,500	251,800
1972	20,000	3,000	39,200	231,500	270,700	1,400	5,366	112,600	413,066
1973	22,000	3,000	43,500	267,000	310,500	1,500	3,100	43,552	383,652
1974	33,390	3,000	48,000	299,000	347,000	1,500	3,471	72,289	460,650
1975	40,555	3,000	52,700	358,120	410,820	1,600	3,576	86,258	545,809
1976	30,921	3,000	56,100	386,050	442,150	1,600	4,039	61,707	543,417
1977	30,400	3,000	60,600	423,000	483,600	1,700	3,700	59,000	581,400
1978	32,500	0	64,100	470,200	534,300	1,900	3,900	63,300	635,900
1979	38,544	3,000	67,600	516,300	583,900	2,000	4,000	71,241	702,685
1980	41,000	3,000	71,100	563,400	634,500	2,200	5,700	71,700	758,100
1981	41,000	3,000	74,800	616,600	691,400	2,300	4,300	76,000	818,000
1982	41,000	3,000	79,600	665,700	745,300	2,500	4,500	80,200	876,500
1983	42,900	3,000	83,500	721,600	805,100	2,800	4,600	9,548	867,948
1984	45,100	3,000	103,600	757,000	860,600	3,100	4,800	62,611	979,211
1985	47,200	3,000	108,900	806,100	915,000	3,400	4,900	45,549	1,019,049
1986	49,300	3,000	113,400	854,800	968,200	3,700	5,100	97,200	1,126,500
1987	51,400	3,000	119,100	904,400	1,023,500	4,000	5,200	101,400	1,188,500
1988	53,500	3,000	123,900	950,700	1,074,600	4,000	5,400	105,600	1,246,100
1989	55,600	3,000	128,200	984,100	1,112,300	4,000	5,600	109,900	1,290,400
1990	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
1991	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
1992	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
1993	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
1994	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
1995	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
1996	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
1997	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
1998	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
1999	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
2000	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
2001	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
2002	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
2003	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
2004	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
2005	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
2006	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
2007	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
2008	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
2009	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
2010	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
2011	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
2012	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
2013	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
2014	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
2015	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
2016	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
2017	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
2018	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
2019	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
2020	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
2021	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
2022	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
2023	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
2024	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
2025	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
2026	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
2027	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
2028	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
2029	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
2030	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
2031	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
2032	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
2033	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
2034	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
2035	57,700	3,000	134,600	1,018,800	1,153,400	4,000	5,700	118,500	1,342,300
TOTAL	3,432,735	199,000	7,693,900	58,053,670	65,747,570	233,900	353,652	6,910,055	76,876,912

Annual Entitlements to Project Water

(Acre-Feet)

Calendar Year	Southern California Area									
	Antelope Valley-East Kern Water Agency (20)	Castaic Lake Water Agency (21)	Coachella Valley Water District (22)	Crestline-Lake Arrowhead Water Agency (23)	Desert Water Agency (24)	Littlerock Creek Irrigation District (25)	Mojave Water Agency (26)	Palmdale Water District (27)	San Bernardino Valley Municipal Water District (28)	San Gabriel Valley Municipal Water District (29)
1962	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0
1968	0	3,700	0	0	0	0	0	0	0	0
1969	0	5,000	0	0	0	0	0	0	0	0
1970	0	5,700	0	0	0	0	0	0	0	0
1971	0	6,700	0	0	0	0	0	0	0	0
1972	20,000	8,936	5,200	526	8,000	170	8,400	1,620	1,677	122
1973	25,000	12,400	5,800	870	9,000	290	10,700	2,940	48,000	11,500
1974	30,000	15,400	6,400	1,160	10,000	400	13,100	4,260	50,000	12,300
1975	35,000	18,200	7,000	1,450	11,000	520	15,400	5,580	52,500	13,100
1976	44,000	21,200	7,600	1,740	12,000	640	17,800	6,900	55,000	14,000
1977	50,000	24,100	8,421	2,030	13,000	730	20,200	8,220	57,500	14,800
1978	57,000	24,762	9,242	2,320	14,000	920	0	9,340	60,000	15,700
1979	63,000	28,000	10,063	2,610	15,000	1,040	24,900	10,260	62,500	16,600
1980	69,200	30,400	10,884	2,900	17,000	1,150	27,200	11,180	65,500	17,400
1981	75,000	32,800	12,105	3,190	19,000	1,270	23,100	11,700	68,500	18,300
1982	81,300	34,800	13,326	3,480	21,000	1,380	22,843	12,320	71,500	19,100
1983	87,700	37,300	14,547	3,770	23,000	1,500	34,300	12,940	74,500	19,900
1984	35,000	39,600	15,768	4,060	25,000	1,610	36,700	13,560	78,000	20,700
1985	40,000	41,800	16,989	4,350	27,000	1,730	39,000	14,180	81,500	21,800
1986	42,000	43,600	18,210	4,640	29,000	1,840	41,400	14,800	85,000	23,200
1987	44,000	45,600	19,431	4,930	31,500	1,960	43,700	15,420	89,000	24,600
1988	46,000	48,000	20,652	5,220	34,000	2,070	46,000	16,040	93,000	26,000
1989	125,700	50,100	21,873	5,510	36,500	2,190	48,500	16,660	97,000	27,400
1990	132,100	52,000	23,100	5,800	38,100	2,300	50,800	17,300	101,500	28,800
1991	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
1992	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
1993	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
1994	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
1995	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
1996	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
1997	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
1998	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
1999	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
2000	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
2001	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
2002	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
2003	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
2004	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
2005	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
2006	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
2007	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
2008	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
2009	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
2010	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
2011	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
2012	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
2013	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
2014	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
2015	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
2016	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
2017	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
2018	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
2019	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
2020	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
2021	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
2022	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
2023	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
2024	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
2025	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
2026	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
2027	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
2028	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
2029	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
2030	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
2031	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
2032	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
2033	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
2034	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
2035	138,400	54,200	23,100	5,800	38,100	2,300	50,800	17,300	102,600	28,800
TOTAL	7,330,000	3,069,098	1,286,111	321,556	2,107,600	127,210	2,810,043	983,720	5,909,177	1,641,322

Annual Entitlements to Project Water

(Acre-Feet)

Calendar Year	Southern California Area				Feather River Area				South Bay Area Future Contractor (38)	Grand Total (39)
	San Gorgonio Pass Water Agency (30)	Metropolitan Water District of Southern California (31)	Ventura County Flood Control District (32)	Total (33)	City of Yuba City (34)	County of Butte (35)	Plumas County FC&WCD (36)	Total (37)		
1962	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	11,538
1968	0	0	0	3,700	0	300	250	550	0	191,500
1969	0	0	0	5,000	0	350	270	620	0	267,395
1970	0	0	0	5,700	0	400	300	700	0	322,600
1971	0	0	0	6,700	0	450	440	890	0	375,590
1972	0	154,772	0	209,423	0	500	470	970	0	741,759
1973	0	354,600	0	481,100	0	600	500	1,100	0	986,252
1974	0	454,900	0	597,920	0	700	530	1,230	0	1,182,200
1975	0	555,200	0	714,950	0	1,050	560	1,610	0	1,386,869
1976	0	655,600	0	836,480	0	1,400	590	1,990	0	1,508,387
1977	0	755,900	0	954,901	0	1,800	620	2,420	0	1,667,321
1978	0	856,300	0	1,049,584	0	1,200	650	1,850	0	1,818,034
1979	0	956,600	0	1,190,573	0	1,450	680	2,130	0	2,028,088
1980	6,800	1,057,000	1,000	1,317,614	0	1,100	710	1,810	0	2,214,770
1981	7,800	1,157,300	2,000	1,432,065	0	1,200	740	1,940	0	2,392,468
1982	8,800	1,257,600	3,000	1,550,449	0	1,200	770	1,970	0	2,574,545
1983	9,800	1,358,000	4,000	1,681,257	0	1,200	800	2,000	0	2,701,994
1984	10,800	1,458,300	5,000	1,744,098	1,600	1,200	830	3,630	0	2,884,337
1985	11,800	1,558,700	6,000	1,864,849	1,700	1,200	860	3,760	0	3,055,846
1986	12,900	1,659,300	8,000	1,983,890	2,100	1,200	890	4,190	0	3,292,290
1987	14,000	1,759,800	10,000	2,103,941	2,500	1,200	920	4,620	0	3,484,115
1988	15,100	1,860,400	13,000	2,225,482	2,900	1,200	960	5,060	0	3,688,335
1989	16,200	1,961,000	16,000	2,424,633	3,300	1,200	1,000	5,500	0	3,958,190
1990	17,300	2,011,500	20,000	2,500,600	3,800	1,200	1,040	6,040	0	4,108,516
1991	17,300	2,011,500	20,000	2,510,200	9,600	1,200	1,080	11,880	0	4,130,856
1992	17,300	2,011,500	20,000	2,510,200	9,600	1,200	1,120	11,920	0	4,138,816
1993	17,300	2,011,500	20,000	2,510,200	9,600	1,200	1,160	11,960	0	4,146,966
1994	17,300	2,011,500	20,000	2,510,200	9,600	1,200	1,200	12,000	0	4,154,201
1995	17,300	2,011,500	20,000	2,510,200	9,600	1,200	1,250	12,050	0	4,163,066
1996	0	2,011,500	20,000	2,492,900	9,600	1,200	1,300	12,100	0	4,152,011
1997	0	2,011,500	20,000	2,492,900	9,600	1,200	1,350	12,150	0	4,155,151
1998	2,000	2,011,500	20,000	2,494,900	9,600	1,200	1,400	12,200	0	4,158,306
1999	3,000	2,011,500	20,000	2,495,900	9,600	1,200	1,450	12,250	0	4,160,436
2000	4,000	2,011,500	20,000	2,496,900	9,600	1,200	1,510	12,310	0	4,162,666
2001	4,000	2,011,500	20,000	2,496,900	9,600	27,500	1,570	38,670	0	4,190,101
2002	5,000	2,011,500	20,000	2,497,900	9,600	27,500	1,630	38,730	0	4,192,141
2003	6,000	2,011,500	20,000	2,498,900	9,600	27,500	1,690	38,790	0	4,194,276
2004	6,500	2,011,500	20,000	2,499,400	9,600	27,500	1,750	38,850	0	4,195,886
2005	7,000	2,011,500	20,000	2,499,900	9,600	27,500	1,810	38,910	0	4,197,096
2006	7,500	2,011,500	20,000	2,500,400	9,600	27,500	1,880	38,980	0	4,198,166
2007	17,300	2,011,500	20,000	2,510,200	9,600	27,500	1,950	39,050	0	4,208,636
2008	17,300	2,011,500	20,000	2,510,200	9,600	27,500	2,020	39,120	0	4,209,406
2009	17,300	2,011,500	20,000	2,510,200	9,600	27,500	2,090	39,190	0	4,210,076
2010	17,300	2,011,500	20,000	2,510,200	9,600	27,500	2,160	39,260	0	4,210,746
2011	17,300	2,011,500	20,000	2,510,200	9,600	27,500	2,240	39,340	0	4,211,526
2012	17,300	2,011,500	20,000	2,510,200	9,600	27,500	2,320	39,420	0	4,212,206
2013	17,300	2,011,500	20,000	2,510,200	9,600	27,500	2,410	39,510	0	4,212,996
2014	17,300	2,011,500	20,000	2,510,200	9,600	27,500	2,500	39,600	0	4,213,786
2015	17,300	2,011,500	20,000	2,510,200	9,600	27,500	2,600	39,700	0	4,214,586
2016	17,300	2,011,500	20,000	2,510,200	9,600	27,500	2,700	39,800	0	4,215,286
2017	17,300	2,011,500	20,000	2,510,200	9,600	27,500	2,700	39,800	0	4,215,886
2018	17,300	2,011,500	20,000	2,510,200	9,600	27,500	2,700	39,800	0	4,216,486
2019	17,300	2,011,500	20,000	2,510,200	9,600	27,500	2,700	39,800	0	4,217,086
2020	17,300	2,011,500	20,000	2,510,200	9,600	27,500	2,700	39,800	0	4,217,686
2021	17,300	2,011,500	20,000	2,510,200	9,600	27,500	2,700	39,800	0	4,217,786
2022	17,300	2,011,500	20,000	2,510,200	9,600	27,500	2,700	39,800	0	4,217,786
2023	17,300	2,011,500	20,000	2,510,200	9,600	27,500	2,700	39,800	0	4,217,786
2024	17,300	2,011,500	20,000	2,510,200	9,600	27,500	2,700	39,800	0	4,217,786
2025	17,300	2,011,500	20,000	2,510,200	9,600	27,500	2,700	39,800	0	4,217,786
2026	17,300	2,011,500	20,000	2,510,200	9,600	27,500	2,700	39,800	0	4,217,786
2027	17,300	2,011,500	20,000	2,510,200	9,600	27,500	2,700	39,800	0	4,217,786
2028	17,300	2,011,500	20,000	2,510,200	9,600	27,500	2,700	39,800	0	4,217,786
2029	17,300	2,011,500	20,000	2,510,200	9,600	27,500	2,700	39,800	0	4,217,786
2030	17,300	2,011,500	20,000	2,510,200	9,600	27,500	2,700	39,800	0	4,217,786
2031	17,300	2,011,500	20,000	2,510,200	9,600	27,500	2,700	39,800	0	4,217,786
2032	17,300	2,011,500	20,000	2,510,200	9,600	27,500	2,700	39,800	0	4,217,786
2033	17,300	2,011,500	20,000	2,510,200	9,600	27,500	2,700	39,800	0	4,217,786
2034	17,300	2,011,500	20,000	2,510,200	9,600	27,500	2,700	39,800	0	4,217,786
2035	17,300	2,011,500	20,000	2,510,200	9,600	27,500	2,700	39,800	0	4,217,786
TOTAL	764,500	112,360,272	988,000	139,698,609	449,900	997,800	112,820	1,560,520	0	235,786,264

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